Curriculum
for
Master of Technology
in
Industrial Engineering and Management
(IEM)

Department of Production and Industrial Engineering

Delhi Technological University

Shahbad-Daulatpur, Delhi-110042

M.Tech. (Industrial Engineering and Management)

M.Tech. (Industrial Engineering & Management) course is meant for those candidates, who are aspiring of higher education in the area of Industrial Engineering & Management. The basic purpose of the course is to serve the society and the nation through teaching, research and development in the area of Industrial Engineering & Management. Our aim is to build a center of excellence to give the interdisciplinary exposure of Industrial processes to improve the organizational efficiency and effectiveness.

The primary research interests fall into three broad themed areas:

- **Decision Science and modelling in management**
- **Sustainable Development**
- **Production and Operations Management**

The overall purpose of the proposed M.Tech. Programme is to establish a cohesive and expanding base of research in Industrial Engineering & Management. It will help in the sustainable growth of the industry, excellence in integrated research and education, and increase in national and international stature and economic competitiveness of Indian industries.

Nowadays, Industrial Engineering and Management has attracted the attention of the researchers and practitioners to solve the industrial problems considering the sustainability and inclusive growth. Demand for the goods and services have been increasing day by day, but the availability of the resources is limited. Thus, It becomes important to improve the way of operations and design of the systems so that the resources can be conserved for future generation. It is important for the industry, society and nation to fulfil the need of the people without harming the ecological systems. The professional must be given a proper exposure of the sustainable growth of the economy. Considering these points, the curriculum of Industrial Engineering & Management has been designed including the recent development in the technology, industrial constraints, and need of the society. There are many recent topics that are included in the curriculum such as Industry 4.0, Circular Economy, Sustainability, Safety and Disaster Management, etc.

The students graduated in this course will be able to handle the difficult situation by proper decision making. They will get the exposure of all the major industrial processes related to the materials management, resource planning, quality management, knowledge management, shop floor management, work design and ergonomics, supply chain management, e-commerce, management information systems, etc.

University Vision

"To be a world class university through education, innovation and research for the service of humanity "

University Mission

1. To establish centres of excellence in emerging areas of science, engineering, technology, management and allied areas.
2. To foster an ecosystem for incubation, product development, transfer of technology and entrepreneurship.
3. To create environment of collaboration, experimentation, imagination and creativity.
4. To develop human potential with analytical abilities, ethics and integrity.
5. To provide environment friendly, reasonable and sustainable solutions for local & global needs.

Program Educational Objectives PEOs

The objectives of the M.Tech. Programme in Industrial Engineering and Management are:

PEO 1: To develop the scientific and engineering manpower of high quality to cater the need of the industries and institutes.

PEO 2: To provide a broad concept of Industrial Engineering & Management.

PEO 3: To provide a deeper understanding of the area of specialization to solve the industrial problems.

PEO 4: To create some innovations for sustainable manufacturing systems.

PEO 5: To provide a capacity to learn continually and interact with interdisciplinary groups.

PEO 6: To develop the students with a capability to cater the requirements and aspirations of the society.

Program Outcomes (PO)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management.

Programme Specific Outcomes (PSOs)

PSO 1: Apply software skills in the field of decision making, optimization, simulation and modeling, statistics for optimal utilization of the different resources and improving the efficiency and affectiveness of the various processes in the industry.

PSO 2: Recognize the need for lifelong learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PSO 3: The student will be employable, able to develop entrepreneurship and be equipped in applying knowledge of Industrial Engineering and management in solving various real time problems and also pursue higher studies.

With these objectives in mind, the M.Tech. Programme has been designed to include courses of study, practicals/seminars and project/thesis through which a student may develop his/her concepts and intellectual skills. The procedures and requirements stated in this proposal embody the philosophy and regulations of the M.Tech. education and ensure a high standard of performance at the University and industries.

This will certainly expand the demonstrated capability of the University in the area of Industrial Engineering & Management applications and to explore research activities that broaden and expand research expertise in this field. It will definitely find appropriate opportunities for educational outreach activities and training courses for other institutes and universities near Delhi to create awareness and to stimulate interest in Industrial Engineering & Management.

Eligibility Criteria: Students with Bachelor degree (4-years degree Programs; B.Tech./B.E/B.Sc.Engg., and equivalent degree) in any branch of Engineering will be eligible to take admission in this program. This program (M.Tech. in Industrial Engineering and Management) is interdisciplinary in nature. For scholarship a valid GATE Score is mandatory.

Total Intake: 30

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)

SCHEME OF FULL TIME M. TECH as per NEP-2020

MASTER OF TECHNOLOGY IN INDUSTRIAL ENGINEERING AND MANAGEMNET(IEM)

Semester-I

Code	Type	Cr	L-T-P	Total Credits	Level
IEM-501	Data Analytics	**4**	3-0-2	24	500-599
IEM 503	Quality Management	**4**	3-0-2		
IEM 505	Production & Operations Management	**4**	3-0-2		
IEM 507	Industry 4.0 & Smart Manufacturing	**4**	3-0-2		
	Department Elective -1				
IEM 511	Product Design & Development		3-0-2		
IEM 513	Modelling & Simulation		3-0-2		
IEM 515	AI/ML in Industrial Engineering and Management	**4**	3-0-2		
IEM 517	Decision Science Modelling		3-1-0		
IEM 519	Logistics & Warehousing Management		3-0-2		
	Self Study				
IEM 551	Seminar				
IEM 553	MOOC	**2**	-		
	Skill Enhancement Course 1				
IEM 541	Supply Chain Analytics		0-0-4		
IEM 543	Professional Software	**2**	0-0-4		
	Audit Course				
UEC 501	English for Research Paper writing		2-0-0		
UEC 503	Disaster Management		2-0-0		
UEC 505	Sanskrit for technical knowledge		2-0-0		
UEC 507	Value Education	**0**	2-0-0		
UEC 509	Constitution of India		2-0-0		
UEC 511	Pedagogy Studies		2-0-0		
UEC 513	Stress Management by Yoga		2-0-0		

DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)

SCHEME OF FULL TIME M. TECH as per NEP-2020

MASTER OF TECHNOLOGY IN COMPUTER AIDED ANALYSIS & DESIGN

Semester-II

Code	Type	Cr	L-T-P	Total Credits	Level
IEM 502	Supply Chain Management	**4**	3-0-2	24	500-599
IEM 504	Advanced Operations Research	**4**	3-0-2		
	Department Elective -2				
IEM 520	Work study and Ergonomics	**4**	3-1-0		
IEM 522	Industrial Waste Management		3-0-2		
IEM 524	Computer Integrated Manufacturing & Robotics		3-1-/0		
IEM 526	Enterprise Resource Planning		3-0-2		
IEM 528	Innovation and Entrepreneurship		3-0-2		
	Department Elective -3				
IEM 530	Value Engineering	**4**	3-1-0		
IEM 532	Live Industry Project		3-1-0		
IEM 534	Management Information Systems		3-1-0		
IEM 536	Principles of Management		3-0-2		
IEM 538	Maintenance Management		3-0-2		
UEC 502	Research Methodology & IPR	**4**	3-1-0		
	Skill Enhancement Course 2				
IEM 540	Industrial Training	**4**	0-0-8		
IEM 542	Professional Software		0-0-8		
	NHEQF Level				**6.5**

Semester-III					
Code	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
IEM 601	Industrial Economics & Management	**4**	3-0-2	16	**600-699***
	Open Elective				
OME601	Optimization Techniques	4	3-1-0		
IEM 603	Minor Project/Research Thesis/Patent	8	-		
Semester-IV					
Code	**Type**	**Cr**	**L-T-P**	**Total Credits**	**Level**
IEM 604	Major Project/Research Thesis/Patent	16	-	16	**-**
	NHEQF Level				**7.0**

SEMESTER -I

Course code: Course Title	Course Structure			Pre-Requisite
IEM-501: Data Analytics	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To familiarize the students with the process of data management analysis of engineering systems and to enhance critical thinking and prepare them for facing business challenges. To familiarize them with statistical analysis and decision making

S. No.	Course Outcomes (CO)
CO1	Find the way of collection, acquisition and organization of the data, and its quality and reliability.
CO2	Analyze and visualize the data associated with the field of the study.
CO3	Use the tools of statistics and machine learning to ask questions and explore patterns in data.
CO4	Execute statistical analyses with professional statistical software such as R-package and Python package.
CO5	Develop the ability to build and assess data-based models and demonstrate skills in data management.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertize over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM-501: Data Analytics)	Contact Hours
Unit 1	**Probability Theory**: Sample Spaces- Events - Axioms – Counting - Conditional Probability and Bayes' Theorem – The Binomial Theorem –Random variable and distributions: Mean andVarianceofaRandomVariable-Binomial-Poisson-ExponentialandNormaldistributions.	8
Unit 2	**Curve Fitting and Principles of Least Squares**- Regression and correlation. Sampling Distributions & Descriptive Statistics: The Central Limit Theorem, distributions of thesample mean and the sample variance for a normal population, Sampling distributions (Chi- Square, t, F, z). **Multipleregression**- Linear models- Logistic regression-Rates and Poisson regression	9
Unit 3	**Test of Hypothesis**- Testing for Attributes – Mean of Normal Population – One-tailed and two-tailed tests, F-test and Chi-Square test, Analysis of variance ANOVA – One way and two-way classifications. Tabular data- Power and the computation of sample size- Advanced data handling	9
Unit 4	**Nonlinear curve fitting**. Density Estimation- Recursive Partitioning- Smoothers and Generalized Additive Models - Survivals Analysis- Analyzing Longitudinal Data- Simultaneous Inference and Multiple Comparisons- Meta-Analysis- Principal Component Analysis- Multidimensional Scaling Cluster Analysis.	8
Unit 5	**Introduction to R- Packages**- Scientific Calculator- Inspecting Variables- Vectors Matrices andArrays- ListsandDataFrames-Functions-StringsandFactors-FlowControland Loops- Advanced Looping- Date and Times. **Introduction to Python Packages**- Fundamentals of Python- Inserting and Exporting Data- Data Cleansing Checking and Filling Missing Data- Merging Data- Operations- Joins.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Richard Cotton, "Learning R", O'Reilly	2013
2	Dalgaard, Peter, "Introductory Statistics with R", Springer Science & Business Media	2008
3	Brain S. Everitt, "A Handbook of Statistical Analysis Using R", Second Edition, LLC	2014

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM-503: Quality Management	L	T	P	NIL
	3	0	2	

Course Objective:
To familiarize the students with the process of data management analysis of engineering systems and to enhance critical thinking and prepare them for facing business challenges. To familiarize them with statistical analysis and decision making

S. No.	Course Outcomes (CO)
CO1	Understand the concepts and importance of quality management in manufacturing and service sector.
CO2	Write proposals to conduct research in areas like Quality Function Deployment, Six sigma, Deming Cycle, QC tools.
CO3	Develop a plan to implement various types of control charts and Acceptance sampling plans.
CO4	Analyze and improve the existing quality management systems in industry and implementation of ISO 9000 standards.
CO5	Develop and implement a plan to train the quality professionals at management level as well as shop floor level.

CO-PO Articulation Matrix						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	1	2
CO2	2	3	2	2	1	2
CO3	3	1	3	2	3	1
CO4	2	3	2	2	3	2
CO5	3	3	2	2	2	3

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes
PO1: An ability to independently carry out research /investigation and development work to solve practical problems
PO2: An ability to write and present a substantial technical report/document
PO3: An ability to demonstrate expertise over the area as per the specialization of the program.
PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.
PO-5: To be able to apply the research knowledge for solution to industry specific problems.
PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM-503: Quality Management)	Contact Hours
Unit 1	**Concepts of Quality Management**: Defining Quality, Basic approaches of QM, Quality philosophies of Deming, Crossby. Juran Trilogy, Ishikawa and Taguchi approach, Cost of Quality.	8
Unit 2	**QM process**: QC tools, Problem-solving methodologies, New, Quality management tools, Quality circles, Benchmarking, KAIZEN, 5S, POKA YOKE concepts,	8
Unit 3	**QM systems**: Quality function deployment, Standardization, Designing for quality, Manufacturing for quality, Failure Mode Effect Analysis, case studies.	8
Unit 4	**Statistical Process Control**: Statistical Quality Control Charts, Advanced Analytical Tools Statistical Design of Experiments; The acceptance sampling fundamental, OC curve, sampling plans.	9
Unit 5	**Quality system**: Need for ISO 9000 system, Advantages, Clauses of ISO 9000, Implementation of ISO 9000. Environment Management Systems, and their economic implications, Six Sigma Tools and Techniques, case studies.	9
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	AmitavaMitra, "Fundamentals of Quality Control and Improvement Management", John Wiley & Sons	2016
2	Dale H.Besterfiled, "Total Quality Management", Pearson Education Asia, (Indian reprint).	2011
3	John Bank, The essence of total quality management PHI	2000
4	Greg Bounds, Lyle Yorks et al, Beyond Total Quality Management, McGraw Hill.	1994

Course code: Course Title	Course Structure			Pre-Requisite
IEM 505 **Production & Operations Management**	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To familiarize the students with the concept Production & Operations Management and to enhance critical thinking and prepare them for facing industrial problems challenges. To familiarize them with corporate and operations strategies

S. No.	Course Outcomes (CO)
CO1	To analyze and describe the corporate and operations strategies.
CO2	Describe the decision-making processes for facility location and layout.
CO3	Estimate the demands using various forecasting models.
CO4	Describe the various models of inventory models for dependent and independent demands.
CO5	Find the best methods to accomplish a job using work study tools and techniques and design the various network models to address the industrial problems

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**2**	**1**	**2**	**2**	**2**
CO2	**3**	**2**	**3**	**1**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**3**	**1**
CO4	**1**	**1**	**3**	**2**	**4**	**1**
CO5	**2**	**1**	**3**	**3**	**3**	**2**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 505 Production & Operations Management)	Contact Hours
Unit 1	Managing operations; planning and design of production and operations systems. Service characteristics. Facilities planning location, layout, and movement of materials. Line balancing	9
Unit 2	Analytical tools and techniques for facilities planning and design. Production forecasting.	8
Unit 3	Aggregate planning and operations scheduling, Production Planning and Control. Purchasing, Materials Management, and Inventory control and JIT Material Requirements Planning.	9
Unit 4	MRPII, ERP, Optimization techniques applications. Work-Study, Value Engineering, Total quality & statistical process control	8
Unit 5	Maintenance management and equipment policies. Network planning and control. World-class manufacturing and factories of the future, Case studies	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Operations Management by Jay Heizer and Berry Render, Pearson Learnings.	2019
2	Operations Management by Russell and Taylor, John Wiley and Sons.	2010

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 507: Industry 4.0 & Smart Manufacturing	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To familiarize the students with the concepts of Industry 4.0 and to enhance critical thinking and prepare them for facing for Smart Manufacturing challenges. To familiarize them with application of the big data analytics to make smart factories

S. No.	Course Outcomes (CO)
CO1	Describe the concepts of Industry 4.0 for Smart Manufacturing.
CO2	Justify the use various hardware used in Smart Manufacturing.
CO3	Describe need of various communication protocols, hardware and software, IoT Layers, and their relative importance.
CO4	Describe the use of cloud-computing IoT platform for Smart Manufacturing.
CO5	Find the application of the big data analytics to make smart factories and implement IoT for smart manufacturing.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 507: Industry 4.0 & Smart Manufacturing)	Contact Hours
Unit 1	**Introduction to Industry 4.0:** Definition of Industry 4.0, The Various Industrial Revolutions, Digitalization, and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation	8
Unit 2	**Internet of Things (IoT)** & Industrial Internet of Things (IIoT) & Internet of Services **Cyber-Physical Systems (CPS) and Cyber-Physical Production Systems (CPPS):** cyber- physical systems (Definitions, demarcation to embedded systems, ubiquitous computing, etc.), Core elements of Cyber-Physical Systems and Cyber-Physical Production Systems, Controltheory,andreal-timerequirements,Self-organizationprinciples("Self-X",autonomy, negotiations),Communicationincyber-physicalsystems,DesignMethodsforCyber-physical Systems (Modelling, Programming, Model-Integrated Development), Applications for cyber-physical systems.	9
Unit 3	**Cloud Manufacturing and the connected factory:** Virtualization, Cloud Platforms, Big data in production, Cloud-based ERP and MES solutions, Connected factory applications, IT security for cloud applications.	8
Unit 4	**Big Data Analytics**: Introduction to the technology used for Big Data analytics and applications in various fields. **BusinessissuesinIndustry4.0:** Opportunities and Challenges, Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.	9
Unit 5	**3Dprinting:** Introduction to 3Dprinting and its applications. **Robotic Automation and Collaborative Robots**, Support System for Industry4.0, Mobile Computing, Related Disciplines, Cyber Security	8
Total		42

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, APRESS	2019
2	Handbook of Industry 4.0 and SMART Systems by Diego Galar, Pascual Pasquale Daponte, Uday Kumar, CRC Press.	2019

**: Latest edition of the title of author may please be listed.*

SEMESTER - II

Course code: Course Title	Course Structure			Pre-Requisite
IEM 502: Supply Chain Management	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To familiarize the students with the current supply chain theories and to enhance critical thinking and prepare them for facing business challenges. To familiarize them with the supply chain management with corporate goals and strategies.

S. No.	Course Outcomes (CO)
CO1	Describe the important role of supply chain management in today's business environment
CO2	Apply the current supply chain theories and concepts utilizing case problems and problem-based learning situations.
CO3	Align the supply chain management with corporate goals and strategies.
CO4	Describe the foundational role of logistics as it relates to transportation and warehousing.
CO5	Analyze and improve supply chain processes and Complete a year-long team research

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**2**	**2**	**1**	**2**
CO2	**3**	**1**	**3**	**2**	**1**	**1**
CO3	**2**	**1**	**3**	**3**	**2**	**1**
CO4	**2**	**2**	**3**	**3**	**2**	**2**
CO5	**3**	**2**	**3**	**3**	**2**	**2**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 502: Supply Chain Management)	Contact Hours
Unit 1	**Role of supply chain management in Economy and Organization**- Introduction to SCM, Evolution, Key concepts, Decisions, and Importance of SCM. Supply chain strategy and Performance Measures- Competitive supply chain strategies, CRM strategy, Supplier relationship strategy- Performance Measures (Financial, Productivity, Quality and cycle time). Supply chain drives- Introduction, Facilities, Inventory, Transportation, and Information. Supply chain design- Network design and operation models.	9
Unit 2	**Sourcing and Transportation**- Role of sourcing, Supplier selection and contracts, Procurement process, Role of Transportation, Design options for the transportation network	8
Unit 3	**Planning and Managing Inventories**-Introduction, cycle/safety/seasonal stock, Inventory for short life cycle products, Multi echelon inventory, Bullwhip Effect, Risk Pooling.	8
Unit 4	**Information Technology in SCM-** Role of IT, E-business and future trends. Supply chain innovations- Introduction, Supply chain integration, Restructuring, Agile supply chains, Case studies.	8
Unit 5	**Supply Chain Vulnerability, Risk, Robustness, and Resilience**: Changing Times and an Uncertain World, The Shortcomings of Risk Management, The Need for Holistic Approaches. **Sustainable Logistics and Supply Chain Systems**: The 'Green Revolution' and Supply Chain Redesign, The Link Between Economic Growth and Transport Growth, The Role of 'Scale' in Logistics and SCM Efficiency Solutions.	9
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Designing and Managing the Supply Chain: David Simchi-Levi, Philip Kaminsky, Edith Simchi – Levi, Ravi Shankar, Mc Graw Hill Education	2008
2	Supply chain management text and cases: Janat Shah, Pearson Education	2009
3	Supply chain management strategy, planning, and operation, Sunil Chopra, Peter Meindl, PHI.	2007

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM-504: Advanced Operations Research	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To apply the most widely used quantitative techniques in decision making. To realize the importance of certain mathematical techniques in getting the best possible solution to a problem involving limited resources.

S. No.	Course Outcomes (CO)
CO1	Apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems.
CO2	Explain the applications of optimization techniques and solve practical problems on linear programming, sensitivity analysis and transportation model.
CO3	Formulate and solve non-linear programming problems and constrained optimization.
CO4	Demonstrate the applications of multi-objective optimization methods.
CO5	Formulate and solve the stochastic programming and solve the problems using heuristic modelling techniques.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**3**	**2**	**2**	**1**
CO2	**3**	**1**	**3**	**3**	**1**	**2**
CO3	**3**	**1**	**2**	**2**	**3**	**1**
CO4	**3**	**1**	**3**	**3**	**3**	**3**
CO5	**2**	**1**	**3**	**3**	**2**	**1**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM-504: Advanced Operations Research)	Contact Hours
Unit 1	Introduction, Classification of optimization problems, Applications of optimization, concepts of design vector, Design constraints, constrain surface, objective function surfaces, and multilevel optimization.	8
Unit 2	Karmakar's method of solving L.P. problems, Quadratic programming, non-linear programming – unconstrained optimization techniques, Basics of constrained optimization.	8
Unit 3	Basics of geometric programming. Multi-objective optimization methods and applications, Formulation of problems – Separable programming and stochastic programming.	9
Unit 4	Introduction to Genetic algorithms, Simulated Annealing, neural network-based optimization, and optimization of fuzzy systems	9
Unit 5	Dynamic Programming: Concept of Dynamic Programming, Multi stage Decision Process, Calculus Method and Tabular Method	
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Kalyanmoy Deb, Optimization for Engineering design – algorithms and examples. PHI, New Delhi	1995
2	SingiresuS.Rao, "Engineering optimization – Theory and practices", John Wiley and Sons.	1998
3	Garfinkel, R.S. and Nemhauser, G.L., Integer programming, John Wiley & Sons.	1972

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
UEC-502: Research Methodology & IPR (Online)	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To familiarize the students with the basic techniques and tools for conducting systematic researchand and develop an understanding of the relevant tools and techniques applicable in proposed area of research. To familiarize them with basic skills in design, implementation and evaluation of research methods to conduct the research.

S. No.	Course Outcomes (CO)
CO1	To introduce research methods and processes.
CO2	To formulate research problem statement and prepare the plan for investigations
CO3	To apply various quantitative techniques for data analysis.
CO4	To communicate and present research findings.
CO5	To understand IPR and related aspects.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**2**	**2**	**2**
CO2	**3**	**3**	**2**	**3**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**3**
CO4	**2**	**2**	**1**	**1**	**2**	**2**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (UEC-502: Research Methodology & IPR (Online))	Contact Hours
Unit 1	Introduction, Concepts of research, Meaning and objectives of research, Research process, Types of research, Research problem identification, Research proposal-contents, Funding agencies, Ethical aspects and Plagiarism detection tools.	8
Unit 2	Research design process, Need and types of research design, Literature survey, Use of internet and advanced search techniques, Various reputed publishers and their databases, identification of research gaps, Measurement and scaling techniques, Data collection-types and methods, Processing and analysis of data, Design and analysis of experiment.	9
Unit 3	Quantitative techniques, sampling fundamentals, Type of hypothesis, Introduction and applications of Binomial, normal and Poisson distributions, Statistical tests: Chi-squared test, t-test, f-test etc., Multivariate analysis, Introduction to various statistical analysis software.	9
Unit 4	Computer applications in research, Pre-writing considerations, Principles of thesis and report writing, Formats for thesis, report and research papers, Documentation and presentation tools- introduction to LATEX and MS Office.	8
Unit 5	Nature of Intellectual Property: Patents, Designs, Trade and Copyright, Process of Patenting and Development: technological research, innovation, patenting, development, new developments in IPR: National and international scenarios.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Dr. C.R. Kothari, "Research Methodology: Methods and Techniques", New Age International Publisher.	2019
2	Stuart Melville and Wayne Goddard, "Research Methodology: An Introduction for Science &| Engineering Students", Juta and Company Ltd.	2004
3	Wadehra B.L., "Law Relating to Patents, Trademarks, Copyright Designs and Geographical Indicators", Universal Law Publishing	2004

**: Latest edition of the title of author may please be listed.*

SEMESTER - III

Course code: Course Title	Course Structure			Pre-Requisite
IEM-601: Industrial Economics & Management	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To familiarize the students with the basic concepts of industrial economics, policies, cost estimation. To impart knowledge about fiscal policies, inflations and study for improvement unemployment.

S. No.	Course Outcomes (CO)
CO1	Describe and determine the effect of financial analysis and its impact on budgeting of projects and their outcomes
CO2	Identify the characteristics of various methods used for the generation of financial management decisions
CO3	Develop and analyze information on investment planning and cost controls, and conduct cost/benefit analysis.
CO4	Quantify and include elements of uncertainty and risk into an economic analysis
CO5	Use modern computer-based tools such a spreadsheet in performing engineering economic analysis

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**2**	**2**	**3**	**3**	**3**
CO2	**2**	**2**	**2**	**3**	**2**	**1**
CO3	**3**	**1**	**2**	**2**	**3**	**1**
CO4	**2**	**1**	**2**	**2**	**2**	**2**
CO5	**2**	**3**	**2**	**2**	**2**	**1**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM-601: Industrial Economics & Management)	Contact Hours
Unit 1	Introduction to Industrial Economics, Scope of Economics, Microeconomics and its importance and limitations, Macroeconomics and its Importance, Macroeconomics Policies, Difference between Micro economics and Macroeconomics Law of Demand and determinants of Demand, Exception of Law of Demand, Elasticity of Demand, Variation in Price Elasticity of Demand, Price Elasticity, Income Elasticity and Cross-price Elasticity, Law of Supply and determinant of Supply, Indifference Curve	8
Unit 2	Theory of Production and Concept of Production Function, Law of Variable Proportion and, Law of Returns, Introduction to Cost Estimation, Various types of Costs, Opportunity Cost, Short-run and long-run costs, Elements of Cost: Direct and Indirect Cost, Break-Even Analysis and its terminology, Sales Mix Break Even Point	9
Unit 3	Introduction to Market Structure, Perfect Competition Market and their Characteristics, Monopoly and its Characteristics, Monopolistic Competition and its characteristics, Oligopoly and its Characteristics, Type of Money, Fiscal Policy 8.4 Monetary Policy and its working	9
Unit 4	Introduction to National Income and its Measurement, National Income, Domestic Product, and Expenditure, Gross National Income, National Income at Current and Constant Price, Stock and flow concept, Gross Domestic Product, Gross National Product and Net National Product, Personal and Disposable Incomes, Inflation and Its Measurement, CPI and RPI, Cost of Inflation, Type of Inflation, Causes and remedies of Inflation.	8
Unit 5	. **Poverty, Unemployment, and Inflation,** Introduction to Scarcity and Economic Problems, Poverty: Absolute, Relative and Asset poverty, Causes of Poverty, Poverty Reduction, Unemployment and its Measurement, Types of Unemployment, Corporate **Social Responsibility (CSR) and Business Ethics,** Introduction to CSR, Importance of CSR, Types of CSR, Nature and Objectives of Ethics, 3C's of Business Ethics, Need and Objectives of Business Ethics	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Engineering Economy and Management by Pravin Kumar, John Wiley	2019
2	Fundamentals of Engineering Economics by Chan S Park, Pearson India	2017
3	Engineering Economy by Sullivan, Wicks, and Koelling Pearson India	2018

**: Latest edition of the title of author may please be listed.*

Department Elective 1

Course code: Course Title	Course Structure			Pre-Requisite
IEM-511: Product Design & Development	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To familiarize the students with the process of product design and development. To impart in-depth knowledge about economic analysis of new products.

S. No.	Course Outcomes (CO)
CO1	Describe the characteristics used for product design and development.
CO2	Assess the customer needs in product design.
CO3	Apply structural approach to concept generation, selection and testing.
CO4	Identify, formulate, and solve engineering problems.
CO5	Identify various aspects of design such as industrial design, design for manufacture, assembly, service and quality and product architecture. Explain various principles and technologies used for the preparation of prototype.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM-511: Product Design & Development)	Contact Hours
Unit 1	Product definition, new product development concept, product development process, consumer behaviour	9
Unit 2	Identifying Customer Needs, Establishing Product specification, Concept Generation, Concept Selection. and product architecture.	9
Unit 3	Industrial Design, Design for manufacturing prototyping, Bathtub Curve concept.	8
Unit 4	Economic Analysis of New products.	8
Unit 5	Test marketing and commercialization of new products.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Chitle A. K and Gupta R.C, Product Design and Manufacturing, PHI	2013
2	Saunders, M.S.and Mc Cornic E.J., 'Human Factors in Engineering & Design', McGraw Hill.	1992
3	Ulrich K. T and Eppinger S.D, Product Design and Development, Mc Graw Hill.	2020

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 513: Modelling & Simulation	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To provide a foundational understanding of system modeling, simulation, and analysis. It introduces the principles of probability and statistics as tools for modeling uncertainty in systems, along with the use of bond graphs for unified physical system modeling. Students will learn various simulation techniques and explore system dynamics of mechanical and hydraulic systems through mathematical modeling and simulation using appropriate software tools, preparing students for real-world engineering applications

S. No.	Course Outcomes (CO)
CO1	Demonstrate understanding of basic probability, statistics, and their role in system simulation.
CO2	Apply bond graph methodology to model physical systems in a unified framework.
CO3	Use simulation techniques including Monte Carlo methods and numerical approaches to evaluate system behaviour.
CO4	Develop and analyse system dynamics models using growth, decay, and logistic functions.
CO5	Construct simulation models of mechanical and hydraulic systems and evaluate their performance using simulation software.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**2**	**2**	**2**	**1**	**1**	**2**
CO2	**3**	**2**	**3**	**3**	**2**	**3**
CO3	**3**	**2**	**3**	**3**	**3**	**3**
CO4	**2**	**1**	**2**	**2**	**2**	**2**
CO5	**3**	**2**	**3**	**2**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 513 :Modelling & Simulation)	Contact Hours
Unit 1	**Introduction:** A review of basic probability and statistics, random variables and their properties, Estimation of means variances and correlation. **Physical Modelling**: Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic activities, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, advantages of simulation	9
Unit 2	**Modeling of Physical System Dynamics: A Unified Approach** Physical systems, Introduction to Bond graphs, Ports, Bonds and Power; Elements of Bond graphs:1-port elements – resistor R, Stiffness C, and Inertia I, Source of Effort Se and Flow SF; 2-port elements – Transformer TF and Gyrator GY, with modulation, Junction elements 1 and 0; Causality, Causality for basic 1-port and multi-ports. Derivation of System equations from Bond graphs in first order state space form.	8
Unit 3	**Bond Graph Modeling of Multi-energy Systems** Mechanical Systems, Translation and rotation (about a fixed axis) **System Simulation**: Techniques of simulation, Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog and Hybrid simulation, Feedback systems, Computers in simulation studies, Simulation software packages	8
Unit 4	**System Dynamics**: Growth and Decay models, Logistic curves, System dynamics diagrams. Probability Concepts in Simulation: Stochastic variables, discrete and continuous probability functions, Random Numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs.	8
Unit 5	**Simulation of Mechanical Systems**: Building of Simulation models, Simulation of translational and rotational mechanical systems, Simulation of hydraulic systems.	9
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	**System Simulation**- Geoffrey Gordon -Prentice Hall	**1978**
2	**System Simulation: The Art and Science** -Robert E. Shannon -Prentice Hall	**2007**
3	**System Modelling and Control** -J. Schwarzenbach and K.F. Gill Edward Arnold	**1978**
4	**Modelling and Analysis of Dynamic Systems** -Charles M Close and Dean K. Frederick Houghton Mifflin	**2001**

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM-515: AI/ML in Industrial Engineering and Management	L	T	P	NIL
	3	0	2	

Course Objective: To familiarize the students with the conceptArtificial Intelligence and Machine Learning. To impart in-depth knowledge of Recurrent Neural Networks, Reinforcement Learning and Markov Decision Processes.

S. No.	Course Outcomes (CO)
CO1	Design and implement supervised learning algorithms, including linear regression and classification models, and evaluate their performance using appropriate metrics.
CO2	Apply unsupervised learning techniques, such as k-means and hierarchical clustering, to real-world datasets and interpret the results.
CO3	Develop and train neural network models, including convolutional neural networks (CNNs) and recurrent neural networks (RNNs), for complex pattern recognition tasks.
CO4	Apply reinforcement learning algorithms, such as Q-learning and policy gradient methods, to create agents capable of solving decision-making problems in simulated environments.
CO5	Critically evaluate the ethical implications of AI technologies and apply principles of responsible AI in the development and deployment of machine learning models and Develop a model using supervised/unsupervised machine learning algorithms for classification/prediction/clustering.

CO-PO Articulation Matrix						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

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S. No.	Content (IEM-515: AI/ML in Industrial Engineering and Management)	Contact Hours
Unit 1	Overview of Artificial Intelligence and Machine Learning, Supervised Learning: labeled data, training vs. testing data, applications. Linear Regression: simple linear regression, assumptions, least squares estimation, cost function, model evaluation (MSE, R^2). Polynomial Regression: polynomial models, overfitting, regularization (Ridge, Lasso). Logistic Regression: sigmoid function, decision boundary, maximum likelihood estimation, cost function, regularization (L1, L2), multinomial logistic regression. Support Vector Machines (SVM): hyperplanes, margins, linear SVM, kernel methods (polynomial, RBF), multi-class SVM, applications. k-Nearest Neighbors (k-NN): distance metrics, choosing k, handling high-dimensional data, scaling, pattern recognition, recommendation systems. Decision Trees: structure, entropy, information gain, Gini impurity, tree pruning, advantages and limitations, use cases. Random Forests: ensemble learning, bagging, out-of-bag error estimation, feature importance, practical applications. Boosting Methods: AdaBoost, gradient boosting, XGBoost, comparison with bagging, real-world applications	9
Unit 2	Introduction to Unsupervised Learning: clustering, dimensionality reduction, anomaly detection, applications. k-Means Clustering: objective function, algorithm steps (initialization, assignment, update), convergence criteria, choosing the number of clusters (Elbow method, Silhouette score), applications (market segmentation, image compression). Hierarchical Clustering: agglomerative vs. divisive methods, dendrograms, linkage criteria (single, complete, average, Ward's method), comparison with k-means, scalability issues, case studies.	8
Unit 3	Introduction to Neural Networks: biological inspiration, perceptron model, artificial 8 neurons (inputs, weights, biases, activation functions), network architecture (input, hidden, output layers), common activation functions (Sigmoid, ReLU, Tanh, Softmax), historical context. Training Neural Networks: forward propagation, cost functions (cross-entropy loss, mean squared error), backpropagation, optimization algorithms (Gradient Descent, Stochastic Gradient Descent, Adam), training challenges (vanishing/exploding gradients, learning rate), case studies. Regularization Techniques: overfitting, dropout, batch normalization, data augmentation, early stopping, practical examples. Convolutional Neural Networks (CNNs): convolution operation, pooling layers, fully connected layers, activation functions, feature extraction, case studies (image classification, object detection). CNN Architectures: historical overview (LeNet, AlexNet, VGG, ResNet), transfer learning, Practical Implementation of CNNs: TensorFlow/Keras, PyTorch, data preprocessing (normalization, augmentation), training CNNs, evaluating performance (confusion matrix, ROC-AUC), deployment strategies, case studies.	9

Unit 4	Recurrent Neural Networks (RNNs) and LSTMs: sequence data, temporal dependencies, RNN architecture, backpropagation through time (BPTT), vanishing/exploding gradients, applications (time series forecasting, text generation), case studies. LSTM Networks: motivation, LSTM architecture (memory cells, gates), comparison with RNNs, applications (NLP, time series forecasting), case studies (sentiment analysis, text generation). Basics of Attention and Transformers: attention mechanisms, self-attention, Transformer architecture (encoder-decoder), applications (NLP, machine translation, text summarization), applications (image classification, NLP), case studies.	8
Unit 5	Introduction to Reinforcement Learning (RL): agent, environment, actions, rewards, states, model-based vs. model-free RL, exploration vs. exploitation (ε-greedy, softmax, UCB), applications (gaming, robotics, recommendation systems), case studies. Markov Decision Processes (MDPs): states, actions, transition probabilities, rewards, Bellman equations (expectation, optimality), value functions (state-value, action-value), policy functions (deterministic, stochastic), solving MDPs (dynamic programming, policy iteration, value iteration), case studies. Q-Learning: off-policy temporal difference learning, Q-learning algorithm (Q-values, learning rate, discount factor), Temporal Difference (TD) learning, SARSA algorithm, convergence, exploration strategies, case studies (grid-world environments)	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Bishop, C. M. (2006). Pattern Recognition and Machine Learning (1st ed.). Springer.	2006
2	Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning (1st ed.). MIT Press.	2016
3	Géron, A. (2022). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd ed.). O'Reilly Media	2022

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM-517: Decision Science Modelling	L	T	P	NIL
	3	0	2	

Course Objective: To familiarize the students with the basic concepts of decision making and its models, Tool and techniques for optimization of decision-making problems.

S. No.	Course Outcomes (CO)
CO1	Demonstrate translating descriptions of decision problems into formal models, and investigate those models in an organized and systematic manner.
CO2	Categorize and construct multistage decision analysis problems using decision trees.
CO3	Categorize and construct multifactor problems with multiple objectives and uncertainty.
CO4	Demonstrate multi-criteria decision-making tools.
CO5	Demonstrate various returns to scale and Data Envelopment Analysis and Develop decision making models under fuzzy environment.

CO-PO Articulation Matrix						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

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S. No.	Content (IEM-517: Decision Science Modelling)	Contact Hours
Unit 1	Decision-Making Models and Theories, Decisions Involving Multiple Objectives, Multiple Objective decision-making Problems Through SMART and Alternative Models.	9
Unit 2	Decision Making under Risk and Uncertainty, Decision Trees, Influence Diagrams and Bayesian Networks, System Dynamic Models, Group Decision-Making & Negotiations.	9
Unit 3	Application of fuzzy sets in optimization and decision-making problems.	8
Unit 4	Multi-criteria decision-making tools-AHP & ANP, Best-Worst Method, TOPSIS, ELECTRE, PROMETHEE, DEMATLE, VIKOR.	8
Unit 5	Data Envelopment Analysis: Return to scale, CCR, and BCC models.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Multiple Criteria Decision Making in Supply Chain Management by Ravindran, A. Ravi, CRC Press	2017
2	Decision Sciences: Theory and Practice: Dutta, Jaydeep, Gupta, Aparna, Sengupta, Raghunandan, Cengage Learning.	2019

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM-519: International Logistics & Warehousing Management	L	T	P	NIL
	4	0	0	

Course Objective: To familiarize the students with the process of Logistics & Warehousing management and to enhance critical thinking and prepare them for facing business challenges.

S. No.	Course Outcomes (CO)
CO1	Describe the logistics distribution systems and multi-model transportation
CO2	Analyze issues in international logistics and warehousing management
CO3	Apply analytical techniques to arrive at cost effective solutions to meet SC requirements of efficiency and responsiveness.
CO4	Manage the coordination among Supply chain partners and service providers.
CO5	Deploy knowledge of regional and international trading blocs in solving problems of international logistics and plan the reverse logistics to enhance the green supply chains

CO-PO Articulation Matrix						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM-519: International Logistics & Warehousing Management)	Contact Hours
Unit 1	**Globalization and International Trade**: Growth in International Trade Measuring Logistics Performance, Globalization, Outsourcing, Offshoring Failures in Outsourcing, Evaluating and Selecting Outsources, Outsourcer and Outsourcee Relationship Development, Supply Chain Integration, Supply Chain Collaboration	9
Unit 2	**Transport in Supply Chains**: Characteristics of the Different Transport Modes, Transport Operations, Distribution Centers and the Role of Factory Gate Pricing, Efficiency of Transport Services, Transport Security, Piracy, Global Transport Security Initiatives, Transport Security Technology, Fourth-Party Logistics, Selecting Logistics Service Providers and Services.	8
Unit 3	**Warehousing and Materials Handling**: Warehousing in Global Supply Chains, Warehouse Layout and Design, Warehouse Management Systems, Materials Handling and Storage, Work Organization and Job Design.	8
Unit 4	**Supply Chain Vulnerability, Risk, Robustness, and Resilience**: Changing Times and an Uncertain World, The Shortcomings of Risk Management, The Need for Holistic Approaches. **Sustainable Logistics and Supply Chain Systems**: The 'Green Revolution' and Supply Chain Redesign, The Link Between Economic Growth and Transport Growth, The Role of 'Scale' in Logistics and SCM Efficiency Solutions.	9
Unit 5	**Reverse Logistics**: Definition, Motivations for Reverse Logistics, Recovery Options in Reverse Logistics, Characteristics of the Remanufacturing Environment in Reverse Logistics, Factors for Successful Reverse Logistics Implementation Performance Measures in Reverse Logistics, Case Studies.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Global Logistics and Supply Chain Management (2nd Edition) Mangam, Lalwani, Butcher, & Javadpour, John Wiley & Sons, 2nd Edition	2011
2	Logistics and Supply Chain Management, Martin Christopher, Pearson Education Limited	2016

**: Latest edition of the title of author may please be listed*

Course code: Course Title	Course Structure			Pre-Requisite
IEM-541: Supply Chain Analytics	L	T	P	NIL
	3	0	2	

Course Objective: To understand the key considerations at the various stages involved in the supply of product in order to maintain the smooth flow from source to the point of consumption so that the overall organizational performance may improve.

S. No.	Course Outcomes (CO)
CO1	Analyze the standardized methods used for value analysis of a project.
CO2	Describe the Value Engineering Job Plan (VEJP), especially in context of the product design process.
CO3	Perform function analysis and FAST diagramming for various projects.
CO4	Apply creative thinking techniques
CO5	Create the value engineering team and discuss the value engineering case studies and evaluate and select Best Value proposals

CO-PO Articulation Matrix						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM-541: Supply Chain Analytics)	Contact Hours
Unit 1	Introduction to mathematical modelling as a tool to address challenges in production logistics and supply chains.	8
Unit 2	Problem formulation and choice of modelling. Linear, dynamic, non-linear, and stochastic programming. Flow and network modelling.	8
Unit 3	Queueing models and Markov chains. Some analytical results and use of discrete event simulation. Monte Carlo simulation. Stochastic inventory models	9
Unit 4	Forecasting. Reliability and maintenance of the production line. Synchronization of maintenance and production activities.	9
Unit 5	Models and visualization of cyber-physical systems in real-time. Decision trees. Expected Utility theory.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Márquez Adolfo Crespo (2010) "Dynamic Modelling for Supply Chain Management: Dealing with Front-end, Back-end and Integration Issues", Springer	2010
2	Simchi-Levi, David, Chen, Xin, Bramel, Julien (2014), "The Logic of Logistics Theory, Algorithms, and Applications for Logistics Management", Third Edition, Springer, ISBN- 978-1- 4614-9149-1	2014
3	Tang Christopher S, Teo Chung-Piaw and Wei Kwok-Kee (Eds) (2008), "Supply Chain Analysis: A Handbook on the Interaction of Information, System and Optimization", Springer, ISBN-13: 978-0-387-75239-6	2008

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM-520: Work study & Ergonomics	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To understand the basics of method and motion study. To impart in depth knowledge of Charting techniques, Concept of standard time and ergonomics and human factors Engineering.

S. No.	Course Outcomes (CO)
CO1	Analyze the basic work content of a specific job for employees of an organization and calculate the production capacity of man power of an organization'
CO2	Analyze the level of risk in a job causing stress, fatigue and musculoskeletal disorders and design appropriate work systems.
CO3	Rate a worker engaged on a live job and calculate basic, allowed and standard time for the same.
CO4	Analyze the existing methods of working for a particular job and develop an improved method through questioning technique.
CO5	Formulate appropriate wage and incentive plan for the employees of an organization.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	IEM-520: Work study Ergonomics	Contact Hours
Unit 1	. **Work-study**: Concept of work and productivity – Productivity measurement - Methods Study Charting techniques – Elemental motions, THERBLIGS and principles of Motion Economy	9
Unit 2	**Work measurement** - Timing techniques - Introduction to predetermined motion time standards. Concept of standard time and benchmark jobs	9
Unit 3	**Organization and methods**: Procedure, analysis, and developing office standards - MTM application to office work - Forms design and control - Records management.	8
Unit 4	Job evaluation and incentive scheme: Job description and job analysis - Job evaluation - different methods - Individual and group incentive concepts and implications - Different types of incentive schemes.	8
Unit 5	**Human factors engineering**: Introduction to ergonomics and human factors Engineering physiological basis of human performance - Biomechanics - Psychology of work and workload perception - Physical work environment - Basis of ergonomic problem identification - Safety.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Introduction to Work Study, I.L.O., 3rd Revised Edn.	1986.
2	Methods, Standards and Work Design, Benjamin W. Niebel and Andris Freivalds, WCB McGraw Hill	1999
3	Human Factors Engineering & Design by Sounders, M.S. and McCormick, E.J., McGraw Hill.	1983

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 522: Industrial Waste Management	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To understand the basics of waste and waste management. To impart in depth knowledge of Recycling and processing of industrial waste, Management of manpower waste and unemployment and Quality and Productivity Management

S. No.	Course Outcomes (CO)
CO1	Describe the industrial processes and their consequences on generation of hazardous wastes.
CO2	Describe the pollution prevention methods and technologies on the field of industrial-hazardous waste management.
CO3	Describe the process of collection and disposal of scrap, surplus, and obsolete items.
CO4	Evaluate the policy options on the field of hazardous waste management.
CO5	Describe the Reduce, Reuse, and Recycle strategies in the waste management.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 522 Industrial Waste Management)	Contact Hours
Unit 1	Introduction to waste and waste management. The concept of wastivity and its inter-relationship with Productivity Quality and Flexibility. Wastivity and productivity measurement.	9
Unit 2	The categories of industrial systems waste. Stages and causes of waste generation in industrial systems. Waste reduction measures and systems in the industry. Collection and disposal system of scrap, surplus, and obsolete items. Recycling and processing of industrial waste. Industrial pollution and environment control.	9
Unit 3	Management of waste in industrial and service sectors. Management of manpower waste and unemployment. Management of energy waste in the national economy. Energy recycling, Waste management, and energy conservation. Total energy concept, overall energy wastivity	8
Unit 4	Interfaces of waste management: environment control, nature conservation, resource development, Quality and Productivity Management	8
Unit 5	Business Process Reengineering. Role of legislation and government. Waste management and national planning	8
	Total	42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Industrial Waste Treatment Handbook, 1st Edition, Butterworth-Heinemann	2001
2	Principles of Industrial Waste Management, Alina Covali, LAPLAMBERT Academic Publishing, Mauritiu	2019
3	Waste Management Practices: Municipal, Hazardous, and Industrial, Second Edition, by John Pichtel	2005

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 524: Computer Integrated Manufacturing & Robotics	L	T	P	NIL
	3	0	2	

Course Objective: To understand the operations and programming of NC, CNC and DNC machines. To understand the concepts of reverse engineering, computer-aided process planning and unmanned manufacturing.

S. No.	Course Outcomes (CO)
CO1	Explain the role of computer and automation in manufacturing.
CO2	Describe the applications of various automation tools and techniques in manufacturing planning and operational processes.
CO3	Demonstrate the knowledge of Material handling and automated storage and retrieval systems.
CO4	Describe the application of robotics in manufacturing systems.
CO5	Explain the Solid Modelling and CAD/CAM processes and describe the need and processes of flexible manufacturing systems

CO-PO Articulation Matrix						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 524 Computer Integrated Manufacturing & Robotics)	Contact Hours
Unit 1	Information to automation & CIM, NC, CNC, DNC, PLC Manual & Computer-aided part programming Group Technology & Computer-aided process planning, Automated Guided Vehicles.	9
Unit 2	Automated material handling system, Automatic storage & retrieval system.	8
Unit 3	CAD/CAM: Solid modelling, a data base for CAD/CAM, and data exchange standards.	9
Unit 4	Robotics in Manufacturing System. Introduction to robots and robotic arms	8
Unit 5	Flexible Manufacturing System.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Ranky P.G. Computer Integrated Manufacturing, Prentice-Hall.	2013
2	MikellP.Groover, Automation, Production Systems and Computer-Integrated Mfg, Prentice	2008
3	Rao, P N, CAD/CAM, TMH	2017

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 526 Enterprise Resource Planning	**L**	**T**	**P**	**NIL**
	4	**0**	**0**	

Course Objective: To understand the importance of enterprise resource planning, benefits ERP Implementation. To impart the knowledge about Business Process Reengineering, and E-Commerce.

S. No.	Course Outcomes (CO)
CO1	Describe the technical aspects of ERP systems.
CO2	Describe the concepts of reengineering and relate to ERP system implementations.
CO3	Describe the advantages, strategic value, and organizational impact of utilizing an ERP system for the management of information across the functional areas of a business.
CO4	List the steps and activities in the ERP life cycle.
CO5	Demonstrate a working knowledge of how data and transactions are integrated in an ERP system to manage the sales order process, production process, and procurement process.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 526 Enterprise Resource Planning)	Contact Hours
Unit 1	**ERP: An Overview** - Benefits of ERP - ERP and Related Technologies - Business Process Reengineering (BPR).	9
Unit 2	**Data Warehousing** - Data Mining - On-line Analytical Processing (OLAP) - Supply Chain Management.	8
Unit 3	**ERP Implementation** - ERP Implementation Lifecycle - Implementation Methodology Vendors, Consultants and Users - Contracts with Vendors, Consultants and Employees Project Management and Monitoring.	9
Unit 4	**Business Modules in an ERP Package** - ERP Market - ERP-Present and Future – Turbo Charge the ERP System.	8
Unit 5	**Enterprise Integration Applications (EIA**) - ERP and E-Commerce - ERP and Internet Future Directions in ERP.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Alexis Leon, ERP Demystified, Tata McGraw–Hill Publishing company limited, New Delhi,	2002
2	Brady, Enterprise Resource Planning, Thomson Learning,	2001
3	S. Sadagopan, ERP: A managerial Perspective, Tata McGraw-Hill publishing company Limited, New Delhi	1999

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 528 Innovation and Entrepreneurship	**L**	**T**	**P**	**NIL**
	4	**0**	**0**	

Course Objective: To understand the overview of innovation and entrepreneurship and its benefits. To impart the knowledge about pattern identification and recognition, business models and business organization.

S. No.	Course Outcomes (CO)
CO1	Describe the attitudes, values, characteristics, behaviour, and processes associated with possessing an entrepreneurial mindset and engaging in successful appropriate entrepreneurial behaviour.
CO2	Describe the entrepreneurship and innovation from both a theoretical and practical perspective, and the role of the entrepreneur in the new enterprise creation process.
CO3	Describe the ways in which entrepreneurs perceive opportunity, manage risk, organise resources and add value.
CO4	Analyze the entrepreneurial and decision-making processes.
CO5	Explain the various business models, lean startups, and business pitching.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 528 Innovation and Entrepreneurship)	Contact Hours
Unit 1	**Introduction to Entrepreneurship**: Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioural; entrepreneurial challenges.	9
Unit 2	**Entrepreneurial Opportunities**: Opportunities. discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering	8
Unit 3	**Entrepreneurial Process and Decision Making**: Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision-making process and approaches, Effectuation and Causation.	9
Unit 4	**Crafting business models and Lean Start-ups**: Introduction to business models; Creating value propositions-conventional industry logic, value innovation logic; customer-focused innovation; building and analyzing business models; Business model canvas, Introduction to lean startups, Business Pitching.	8
Unit 5	**Organizing Business and Entrepreneurial Finance**: Forms of business organizations; organizational structures; Evolution of Organization, sources, and selection of venture finance options and its managerial implications. Policy Initiatives and focus; the role of institutions in promoting entrepreneurship.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Ries, Eric, The Lean Start-up: How constant innovation creates radically successful businesses, Penguin Books Limited.	2011
2	Blank, Steve), The Startup Owner's Manual: The Step by Step Guide for Building a Great Company, K&S Ranch.	2013
3	S. Carter and D. Jones-Evans, Enterprise and small business- Principal Practice and Policy, Pearson Education	2006

**: Latest edition of the title of author may please be listed.*

Department Elective 3

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
IEM-530: Value Engineering	4	0	0	**NIL**

Course Objective: To understand the overview of value engineering and its concepts. To impart the knowledge about value engineering team, and function analysis system techniques.

S. No.	Course Outcomes (CO)
CO1	Analyze the standardized methods used for value analysis of a project.
CO2	Describe the Value Engineering Job Plan (VEJP), especially in context of the product design process.
CO3	Perform function analysis and FAST diagramming for various projects.
CO4	Apply creative thinking techniques
CO5	Create the value engineering team and discuss the value engineering case studies and evaluate and select Best Value proposals

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM-530: Value Engineering)	Contact Hours
Unit 1	An overview of value engineering (VE) - Definition, Concepts, and approaches of value analysis and engineering – evaluation of VE.	8
Unit 2	Evaluation of function, Problem setting system, problem-solving system, setting and solving management-decision – type and services problem, evaluation of value. Results accelerators	9
Unit 3	Basic steps in using the systems Value analysis - Understanding the decision environment, Effect of value analysis on other work in the business.	9
Unit 4	VE Team, Co-ordinate, designer, different services, definitions, construction management contracts, value engineering case studies,	8
Unit 5	Effective organization for value work, function analysis system techniques-FAST diagram.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Parker, D.E.," Value Engineering Theory", Sundaram Publishers.	1990
2	Miles, L.D., "Techniques of Value Engineering and Analysis", McGraw Hill Book Co., 2nd End.	1972
3	Tufty Herald, G. Compendium on Value Engineering, The Indo American Society, 1st Edn	1983

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
	L	T	P	
IEM 532: Live Industry Project	3	0	2	NIL

Course Objective: To understand the need of live industry project and apply basic concepts to solve industrial problems. To impart the knowledge about various techniques of Project planning.

S. No.	Course Outcomes (CO)
CO1	Identify skills and capabilities that intersect effectively with the needs of industry.
CO2	Apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach.
CO3	Demonstrate and apply research skills to complete a project.
CO4	Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.
CO5	Apply the risk management plan and analyses the role of stakeholders.

CO-PO Articulation Matrix						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertize over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 532 Live Industry Project)	Contact Hours
	In this elective, the students will take a live project from the industry. The evaluation will be based on the submission of the project report and its presentation.	

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 534: Management Information Systems	**L**	**T**	**P**	**NIL**
	4	**0**	**0**	

Course Objective: To familiarize the students with the concepts information technology and information systems and its related applications in business.

S. No.	Course Outcomes (CO)
CO1	Describe the role of information technology and information systems in business
CO2	Develop the necessary skills to construct a theoretical database model given a specific application case study
CO3	Compare the processes of developing and implementing information systems.
CO4	Translate the role of information systems in organizations, the strategic management processes, with the implications for the management.
CO5	Analyze and synthesize business information and systems to facilitate evaluation of strategic alternatives and apply the understanding of how various information systems like DBMS work together to accomplish the information objectives of an organization

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 534 Management Information Systems)	Contact Hours
Unit 1	Concepts of MIS: Global factors responsible for the growth of information systems, Types of Information Systems Evolution of information theory, Characteristics of management information System,	8
Unit 2	Richard Nolan MIS Stages theory, Information Resource Management, Management information system organization functions MIS Long-range planning Meaning and role of MIS in an organization. Analysis and design of information systems.	9
Unit 3	Conceptual modelling of data and process in organizations: System development life cycle model, Methods of collection of data, tools for modelling and analysis of data.	8
Unit 4	Concept of Data, Base Database management systems and its functions Data flow diagram, Data dictionary, Data banks.	8
Unit 5	Tools for modelling and analysis of processes: Flow charts, Decision tables, Decision trees. Transform analysis, Transaction analysis. Information systems audit. Impact of MIS on organizations. The usefulness of various industrial engineering techniques in the design of MIS.	9
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Management Information Systems, Lauden and Lauden, PHI	1999
2	Management Information Systems by Jerome kanter	1984
3	Management Information Systems by Davis Gordon.	2004

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 536: Principles of Management	**L**	**T**	**P**	**NIL**
	4	**0**	**0**	

Course Objective: The basic objective of this course is to make students aware of fundamental concepts of t management necessary for making decisions in complex business situations by managers and start up entrepreneurs

S. No.	Course Outcomes (CO)
CO1	Evaluate the global context for taking managerial actions of planning, organizing and controlling
CO2	Assess global situation, including opportunities and threats that will impact management of an organization.
CO3	Integrate management principles into management practices.
CO4	Assess managerial practices and choices relative to ethical principles and standards.
CO5	Determine the most effective action to take in specific situations. and Evaluate approaches to addressing issues of diversity

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 536 Principles of Management)	Contact Hours
Unit 1	Management principles: Management functions, Roles & Skills, History of management thought - Various theories and approaches to management, Management by objectives Formal and informal organizations: organization structure and design – Organization principles of line and staff authority and span of control	9
Unit 2	Motivation Theory: Concept of Motivation, Maslow Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory, McGregor's Theory X and Theory Y and Theory Z, Motivational applications.	8
Unit 3	Decision Making: Planning process, tools, and techniques: Fundamentals of Directing, Decision-making process, approaches, and aids.	8
Unit 4	Leadership: Concept of Leadership, Leadership theories, Leadership Styles, Concept of Power and Concept of Authority and Responsibility, Delegation, decentralization, and autonomy	8
Unit 5	Communication: Concept of Communication, types of communication, aids, and Barriers in communication, Conflict, and Coordination. Managerial control-need and principles: Role of information in control - Control methods and techniques - Managerial ethics and social responsibility.	9
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Industrial Engineering and Management by Pravin Kumar	2015
2	Principles and Practice of Management by L.M. Prasad.	2020
3	Introduction to Management by Plankett, W.R. and Attner, R.F., Kent Publishing Company.	2009

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 538: Maintenance Management	**L**	**T**	**P**	**NIL**
	4	**0**	**0**	

Course Objective: To familiarize the students with the basics of reliability and its configurations, reliability models, Maintainability. To impart in-depth knowledge about Overhaul and Repair Decisions, Spares Provisioning. And soft skill tools for different types of reliability problems.

S. No.	Course Outcomes (CO)
CO1	Use the contemporary maintenance management practices.
CO2	Analyze and improve the reliability of a system.
CO3	Assess the regular and sudden failures in machines and structures and determine their root cause.
CO4	Implement the replacement policies to minimize the down-time.
CO5	Maximize the profitability and availability of the equipment and Develop strategy based maintenance framework suitable to any given industrial scenario.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 538 Maintenance Management)	Contact Hours
Unit 1	Reliability: Hazard rate, mean time to failure. Hazards models. Constant hazard Weibull model. System Reliability: Series, parallel, and mixed configurations. k-out-of-n-structure. Economics of introducing a standby or redundancy into a production system, optimum design configuration of a series/parallel system: maximizing reliability subject to budgetary constraint optimum level of active parallel redundancy for equipment with components subject to failure.	9
Unit 2	Maintainability: Maintainability increment Equipment and mission availability. Replacement Decisions: Economic models block replacement policy, age replacement policy, replacement policies to minimize downtime, the economics of preventive maintenance.	8
Unit 3	Inspection Decisions: Optimal inspection frequency to profit-maximizing, minimization of downtime, and availability maximization.	8
Unit 4	Overhaul and Repair Decisions: Optimal overhaul/repair/replace maintenance policies for equipment subject to breakdown finite and infinite time horizon. Optimal repair effort of a maintenance workforce to meet fluctuating taking into subcontracting opportunities.	9
Unit 5	Spares Provisioning: Spares provisioning for single and multi-echelon systems under budgetary constraints. Maintenance organization: Computer application in maintenance management, MIS for maintenance.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Gopalakrishnan, P. and Banerji, A.K. (2009), Maintenance and Spare Parts Management, PHI Learning	2009
2	. Srivastava, SK. (2012), Maintenance Engineering Principles, Practices and Management, S.Chand Publishers	2012

**: Latest edition of the title of author may please be listed.*

Open Elective 1

Course code: Course Title	Course Structure			Pre-Requisite
OME601: Optimization Techniques	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To allow students to develop the technical, analytic, and managerial skills necessary to perform the tasks successfully

S. No.	Course Outcomes (CO)
CO1	Apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems.
CO2	Apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems.
CO3	Formulate and solve non-linear programming problems and constrained optimization
CO4	Demonstrate the applications of multi-objective optimization methods
CO5	Formulate and solve the stochastic programming and Solve the problems using heuristic modelling techniques.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**3**
CO4	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

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S. No.	Content (OME601 Optimization Techniques)	Contact Hours
1	Introduction to Optimization; Introduction, Engineering Applications, Statement of an Optimization Problem, Classification; Linear Programming: Simplex Algorithm; Two Phase Method, Big 'M' Method, Revised Simplex Method, Duality in Linear Programming; Prime-Dual Relations, Duality Theorem, Dual simplex method, Sensitivity and Post Optimality Analysis	9
2	Transportation and Assignment Problem; Integer Programming – Branch and bound Method, Cutting Plane Method	8
3	Dynamic Programming: Elementary Concepts of Dynamics Programming, Multi stage Decision Process, Calculus Method and Tabular Method; Classical Optimization techniques – Unconstrained Optimization: Optimizing Single-Variable Functions, Optimizing Multi-Variable Functions.	8
4	Constrained Optimization: Optimizing Multivariable Functions with Equality Constraint: Lagrange Multipliers Method. Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions, Kuhn –Tucker Sufficient Conditions; Non-Linear Programming-Unconstrained Optimization Techniques: Direct search methods, Descent Methods.	9
5	Constrained Optimizations: Direct and Indirect methods- Introduction to Advanced Optimization Techniques –Genetic Algorithms (GA), Simulated Annealing, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) etc.	8
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Optimization of Engineering Design by Deb, K., PHI	2021
2	Operations Research by Hamdi A. Taha, Pearson	2006
3	Operations Research by D.S. Hira, P. K. Gupta, S. Chand	1995

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM-6023: Knowledge Management	L	T	P	NIL
	4	0	0	

Course Objective: Preparing the students to understand how the new age organizations are leveraging on the power of knowledge and technology. Acquiring the knowledge to address the issues faced by the corporate world for a deeper understanding.

S. No.	Course Outcomes (CO)
CO1	Apply complex theories and practice of knowledge and intellectual capital management.
CO2	Describe the major roles and responsibilities of the manager in knowledge management implementations
CO3	Formulate action plans for knowledge intensive organizations.
CO4	Describe the ways to preserve and apply the human expertise.
CO5	Identify some of the key tools and techniques used in knowledge management applications and describe the methods to convert the Tacit knowledge to Explicit knowledge.

CO-PO Articulation Matrix						
COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM-6023: Knowledge Management)	Contact Hours
Unit 1	**Overview of Knowledge Management**: Introducing Knowledge Management, need for Knowledge Management, Forces Driving Knowledge Management, Issues in Knowledge Management. Cognitive Psychology, Data, Information and Knowledge, Kinds of Knowledge, Expert Knowledge, Thinking and Learning in Humans, Knowledge vs Intelligence, dumb search, Heuristic search in Knowledge-Based Systems. Knowledge Management Systems Life Cycle: Challenges in KM Systems Development, Conventional Vs KM Systems Life Cycle (KMSLC), Key Differences, Key Similarities, KMSLC Approaches. Knowledge Creation, Nonaka's Model of Knowledge Creation & Transformation, Knowledge Architecture, Acquiring the KM System.	9
Unit 2	Knowledge Capturing Techniques: On-Site Observation (Action Protocol), Brainstorming, Electronic Brainstorming, Protocol Analysis (Think-Aloud Method), Consensus Decision Making, Repertory Grid, Nominal Group Technique (NGT), Delphi Method, Concept Mapping, Blackboarding.	8
Unit 3	Knowledge Codification: Modes of Knowledge Conversion, Codifying Knowledge, Codification Tools/Procedures Knowledge Maps, Decision Table, Decision Tree, 42 Frames, Production Rules, Case-Based Reasoning, Knowledge-Based Agents, Knowledge Developer's Skill Set, Knowledge Requirements, Skills Requirements Learning from Data: The Concept of Learning, Data Visualization, Neural Network (Artificial) as Learning Model, Supervised/Unsupervised Learning, Applications in Business, Relative Fit with KM, Association Rules, Classification Trees.	8
Unit 4	Preserving and Applying Human Expertise: Knowledge-Based Systems: Knowledge-Based System: User's View, Developer's View, Knowledge Representation: Rules, Inference chains, Knowledge Representation: Frames, Functional attributes, Frame-Based Reasoning, Rule-Based Reasoning, forward chaining: Rule Interpretation Process, Backward chaining: Rule Interpretation Process, Backward chaining: Closed World Assumption, Knowledge engineering, Tools. Case-Based Reasoning Systems: Weaknesses of rule-based systems, Case Based Reasoning (CBR), Case-Based Reasoning (CBR): Adaptation, Case-Based Reasoning (CBR): Successful vs failed cases, Indexing the case library: Flat Library, Indexing the case library: Shared feature networks, Indexing the case library: Redundant shared feature networks, Advantages and Disadvantages of Case-based systems.	9
UNIT 5	Knowledge Elicitation: Converting Tacit Knowledge to Explicit: Basic One-On-One Interviews: Specific Problem-Solving, Knowledge-Gathering Sessions, Basic One-On One Interviews: Knowledge Elicitation Sequence, Observational Elicitation, Observational Elicitation: Quiet on-site observation, Exercising the expert, Problem description and analysis, Role Reversal Techniques, Team Interviewing,	8

	Team Interviewing: One-on-many, Team Interviewing: Many-on-many, Many-on-one.	
Total		42

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint***
1	Dalkir, K. (2011). Knowledge Management in Theory and Practice (2nd edition). Cambridge, Massachusetts: The MIT Press	2011
2	Hislop, D., Bosua, R., & Helms, R. (2018). Knowledge management in organizations: A critical introduction. (4th edition) Oxford: Oxford University Press	2018
3	Mohapatra, S., Agrawal, A., &Satpathy, A. (2016). Designing Knowledge Management-Enabled Business Strategies. Switzerland: Springer	2016

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 6024: Reliability Engineering	**L**	**T**	**P**	**NIL**
	4	**0**	**0**	

Course Objective: To develop the ability in formulating suitable maintenance strategies to achieve reliable a manufacturing system. To equip with essential system diagnosis techniques so that students can identify and take appropriate actions on error symptoms and causes of failures.

S. No.	Course Outcomes (CO)
CO1	To understand major concepts of reliability prediction
CO2	To analyze statistical experiments leading to reliability modeling (DFM) implications of design choices for specific manufacturing processes
CO3	To identify reliability testing components
CO4	To apply reliability theory to assessment of reliability in engineering design
CO5	To estimate reliability functions and parameters of product/component systems using reliability block diagram, fault tree and event tree and evaluate maintainability and availability of product/component systems, and different maintenance strategies.

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**3**
CO4	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

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S. No.	Content (IEM 6024Reliability Engineering)	Contact Hours
Unit 1	Introduction: System concepts in reliability, availability and maintainability (RAM) Engineering, Practical applications of RAM Engineering to systems, products and processes; Concepts, terms and definitions	8
Unit 2	Failure rate function, Probability density function, Cumulative distribution function, reliability function, Mean time to failure (MTTF), MTBF, MTTR; Fundamentals of reliability: Failure distributions; Exponential, Weibull, Normal and Lognormal; Constant failure rate model and time dependent failure models	8
Unit 3	System reliability assessment: Series, Parallel, Combined series-parallel configurations; Cut sets and path sets approach, fault tree analysis (FTA); State dependent systems; Markov analysis, load sharing system, standby system, degraded system, Monte Carlo simulation; Design for Reliability and reliability improvement: Reliability specifications and system measurements	9
Unit 4	reliability allocation; exponential case, optimal allocations, arnica method, AGREE method, Various types of redundancies; active and passive redundancy, k-out-of-n-redundancy, standby redundancy, optimization, reliability-cost trade off; Availability and maintainability: Point, mission and steady state availability;	8
Unit 5	Availability assessment, Maintainability and its assessment; Maintenance policies: individual policy, Planned, preventive and condition based maintenance; Opportunistic maintenance policy; Design for maintainability: Maintenance requirements, measurements and specifications, fault diagnosis, failure mode and effect analysis (FMEA), Parts standardization and interchangeability, modularization, accessibility, repair versus replacement, proactive maintenance, maintainability prediction and demonstration.	9
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Reliability Engineering by Srinath, L. S., East –West Press Ltd., New Delhi	2005
2	Engineering Maintainbility by Dhillon, B. S., Prentice Hall of India, New Delhi	1999

**: Latest edition of the title of author may please be listed.*

Course code: Course Title	Course Structure			Pre-Requisite
IEM 6025: Safety and Disaster Management	**L**	**T**	**P**	**NIL**
	3	**0**	**2**	

Course Objective: To understand the fundamentals of safety, disaster, different Types of Disaster. To impart knowledge about risk, its concept and analysis and reconstruction and rehabilitation as a means of development

S. No.	Course Outcomes (CO)
CO1	Analyze the need and significance of disaster management in an industry.
CO2	Explain the different types of disasters and causes for disasters.
CO3	Describe the strategic development for vulnerability and risk reduction.
CO4	Analyze the disaster preparedness and safety measures.
CO5	Describe the role of Information Technology in Disaster Management

CO-PO Articulation Matrix						
COs	**POs**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**2**	**3**
CO4	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**

Three values 1/2/3 (1 indicates low, 2 indicates medium, and 3 indicates high) can be filled for CO-PO articulation matrix. As per NBA, there are three standard POs that are given below.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

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

PO3: An ability to demonstrate expertise over the area as per the specialization of the program.

PO-4: To integrate basic and advance research knowledge for identification and formulation of problem statement to focus on alternate approaches for their solution.

PO-5: To be able to apply the research knowledge for solution to industry specific problems.

PO6: To demonstrate a master degree over the area as per Industrial Engineering and Management. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Note: Program may add up to three additional POs approved by BOS of the department.

S. No.	Content (IEM 6025: Safety and Disaster Management)	Contact Hours
Unit 1	**Safety**: Henrichs Axioms of Industrial Safety, Concepts of Safety, Organization for Safety, Organization, Definition, Need & Principles Organizing for Health, And, Environmental, Activities, Organization Structure, Function & Responsibilities **Disaster:** Different Types of Disaster- Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides, etc. Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism, etc. Causes, effects, and practical examples for all disasters.	9
Unit 2	**Risk and Vulnerability Analysis**: Risk- Its concept and analysis, Risk Reduction, Vulnerability- Its concept and analysis, Strategic Development for Vulnerability Reduction.	7
Unit 3	**Disaster Preparedness**: Disaster Preparedness: Concept and Nature, Disaster Preparedness Plan, Prediction, Early Warnings and Safety Measures of Disaster, Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies. Role of IT in Disaster Preparedness, Role of Engineers on Disaster Management.	9
Unit 4	**Disaster Response**: Introduction, Disaster Response Plan, Communication, Participation, and Activation of Emergency Preparedness Plan, Search, Rescue, Evacuation and Logistic Management, Role of Government, International and NGO Bodies, Psychological Response and Management (Trauma, Stress, Rumor, and Panic), Relief and Recovery 8. Medical Health Response to Different Disasters.	8
Unit 5	**Rehabilitation, Reconstruction and Recovery**: Reconstruction and Rehabilitation as a Means of Development. Damage Assessment, Post Disaster effects and Remedial Measures, Creation of Long-term Job Opportunities and Livelihood Options, Disaster Resistant House Construction, Sanitation and Hygiene, Education and Awareness, Dealing with Victims' Psychology, Long-term Counter Disaster Planning, Role of Educational Institute.	9
Total		42

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint*
1	Disaster Management by Mrinalini Pandey, Wiley India Pvt. Ltd.	
2	Disaster Science and Management by Tushar Bhattacharya, McGraw Hill Education (India) Pvt. Ltd	
3	Disaster Management: Future Challenges and Opportunities by Jagbir Singh, K W Publishers Pvt. Ltd	

**: Latest edition of the title of author may please be listed.*