



Department of Industrial &  
Manufacturing Engineering,  
NED University of Engineering  
& Technology

*Offers*

**MASTER DEGREE PROGRAMME**

*"Transform Knowledge into Impact..."*

# MANUFACTURING ENGINEERING

WEEKDAYS (Monday - Friday)

**MASTER OF  
ENGINEERING**  
(M. Engg.)

ADMISSIONS  
**OPEN**

## CONTACT US

**Dr. Ali Zulqarnain**  
(M. Engg. /MEM Coordinator)

**Queries Assistance by Mr. Danish Khalil**  
(Executive Master's Programme)

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## VISION



To be the Leader in the field of Industrial and Manufacturing Engineering, to produce High Quality Leaders and Managers for the industry.

## MISSION



Aims to be the leading entity in the relevant field by High Quality Research, Education and Innovation to produce competent Human Resource, Capable of Performing Complex Task in an Environment Friendly and Socio-economic manner.

## UN SDGS FOR THE BETTER PLANET



## ABOUT THE DEPARTMENT



The Department was initially started under the auspices of Mechanical Engineering Department in October 1999 and started as a separate Department in October 2000 with the name of Industrial & Manufacturing Engineering Department (IMD).

The Department is offering Master of Engineering (by course work) with the Specializations in Manufacturing Engineering and Engineering Management. The Engineering Management program further offers choices of Specialization in (IM) Industrial Management (Weekdays & Weekend Programmes), Quality Management (QM), and Supply Chain Management (SCM). The Department of Industrial & Manufacturing Engineering has highly qualified and experienced regular and visiting faculty members.

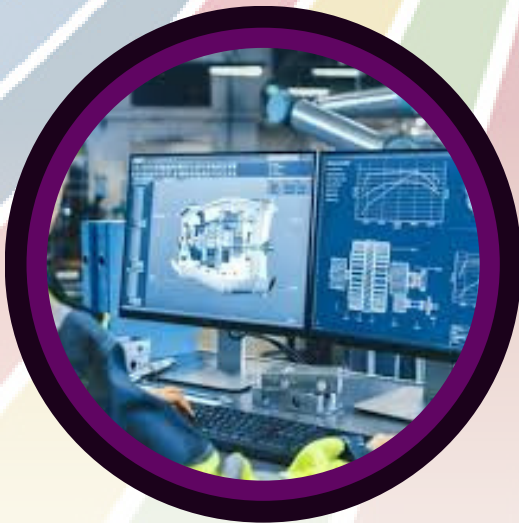
*"The quality of a product is a direct reflection of the Process used to create it"*  
(Shigeo Shingo)

# ABOUT THE PROGRAMME

## AN INTRODUCTION

### PROGRAMME MISSION

The mission of the programme is to create Technical and Analytical Expertise for Goods Producing and Service Industries, and impart the Knowledge of Operations and Projects for the Analysis, Design and Evaluation of Socio-technical Systems in the industry.



*The Master's Programme in Manufacturing Engineering (M. Engg.) is designed to equip students with advanced skills and knowledge in the Planning, Design, and Optimization of Manufacturing Processes. This program focuses on the integration of Cutting-edge Technologies, Automation, and Quality Engineering within Industrial Production. Students gain a deep understanding of Materials, Processes, and Systems Engineering, preparing them for leadership roles in the Manufacturing Sector.*

*Professionals of Manufacturing Engineering's competency shortfalls are intended to be filled by the M. Engg. Programme. Professionals additionally acquire the abilities required for the Fourth Industrial Revolution (I4.0) and Advance their careers in the Rapidly Evolving Sector of Manufacturing Engineering.*

# MEASURABLE PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

1. To develop necessary and advanced analytical, technical and research skills in the field of engineering that respond directly to fulfil the goals and needs of industry, academia and research.
2. To develop university-industry relationship through the graduating students (students joining graduate programme from different industries).
3. To enhance the understanding of problem solving. This can be achieved by using developed knowledge and techniques to obtain solutions that necessarily meet the changing demands of society and for betterment of human life.
4. To develop the skills in the field of manufacturing engineering for career development.
5. To create the ability of networking in graduating students for enhancing understanding, critical thinking and brainstorming.



# MEASURABLE PROGRAMME LEARNING OUTCOMES (PLOS)

- a) Development of engineering expertise in product design, tools and environment, to fulfil the industrial requirement.
- b) Students shall have ability to analysis and control the Industrial and Manufacturing operations using; statistical, calculus-based methods, simulation and information technology.
- c) Students shall have an ability to use modern tools, techniques, and skills necessary for practicing mechanical engineering including computational tools, statistical techniques, and instrumentation.
- d) Students shall have an ability to apply knowledge of applied sciences, management, computer-based technologies and principles of Industrial and Manufacturing Engineering.
- e) Students shall have an understanding of the professional and ethical responsibilities of engineers.
- f) Students shall have an understanding of social systems in manufacturing environment.
- g) Students shall have skills to prepare financial analyses of projects, operations and firms.
- h) Students shall be able to prepare technical reports along with oral communication skills and the knowledge of environmental issues in relation to technology.

*"There is one rule for the industrialist and that is: make the best quality of goods possible, at the lowest cost possible, paying the highest wages possible"*  
(Henry Ford)

# KEY BENEFITS

- **Advanced Technical Expertise:** Programme offers students extensive scientific understanding, enabling them to succeed in the rapidly evolving field of engineering innovations and challenges.
- **Cutting-edge Technology Intergration:** Programme is unique in that it provides students with state-of-the-art technological integration, allowing them to utilise latest advances and apply them to real-world engineering solutions with ease.
- **Optimization of Mfg. Processes:** Programme focuses on manufacturing process optimisation, helping students learn the nuances of increasing productivity, cutting expenses, and improving overall performance in the fast-paced world of industrial production.
- **Smart Manufacturing Systems:** Programme focuses on manufacturing process optimisation, helping students learn the nuances of increasing productivity, cutting expenses, and improving overall performance in the fast-paced world of industrial production.
- **Quality Engg./Mgm.:** Programme develops a leadership mindset in quality engineering/management, enabling students the strategic understanding necessary to promote excellence, maintain high standards, and lead innovative endeavours in the field of engineering quality.
- **Digitalization & Sustainability:** Programme provides thorough instruction on sustainability and digitalization, promising that students understand how to use digital technology to progress engineering while promoting eco-friendly behaviours for a sustainable future.
- **Research Skills:** Programme places a strong emphasis on the development of strong research skills, allowing students the ability to carry out creative and significant research in the many and constantly changing domains of engineering.
- **Operational Excellence:** Programme serves as a catalyst for organisational growth, offering graduates a life-changing educational experience and the skills necessary to drive innovation, overcome challenging technical problems, and enhance the success of their individual companies.
- **Any many more.....**



# SALIENT FEATURES

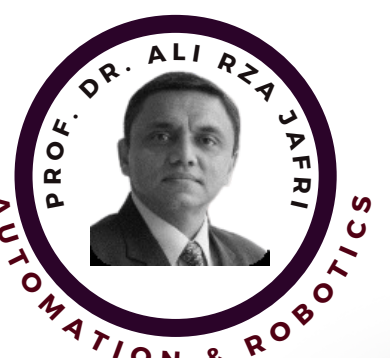
- Programme is Recognized by HEC (NOC acquired).
- Specialized Ph.D. Faculty / Industry Experts are engaged.
- Case Study based Teaching.
- Real-industry Scenario discussion.
- Seminars/Guest Speakers by Field Experts.
- Students are representing from Middle to Top Management.
- Networking.
- Guidelines for International Certifications.
- Digital Library Facilities.

# WHO SHOULD ATTEND

- Bachelor Degree in Industrial & Manufacturing Engineering or Allied Disciplines.
- Open Enrollment through NED Academy: Enterprise Engineers who are committed to developing their competencies of Manufacturing. Engg.

# INTERNAL

## A FEW FACULTY & EXPERTISE



- As Visiting Faculty, Industry Experts are also engaged in the Programme.

*"Waste is worse than loss"*  
(Thomas Edison)

# PROGRAMME OVERVIEW

## ADMISSION PROCEDURE

Programme Length

**2.5 YEARS**

Semester

05 Semesters  
Per Semester: 06 Months

Total Courses

10, (OR) 08 with Thesis

Total Credit Hours

30

Courses/Semester

02

Class Schedule

02 Days, 6:00 - 9:00pm

**01**

### APPLICATION FORMS

Application Forms are available at university website under "Postgraduate Admission" and to be submitted in the concerned department.

### ELIGIBILITY CRITERIA

Bachelor's Degree in Industrial & Manufacturing Engineering or Allied disciplines, 1st Division (Annual System) or at least with CGPA 2.40 / 4.0 (Semester System), Professional Bachelors Degree must be accredited by Pakistan Engineering Council (PEC) / Higher Education Commission (HEC).

**02**

**03**

### PRE-ENTRY TEST

It will be held in concerned department.

### INTERVIEW

Optional as per need.

**04**

**05**

### FINAL LIST OF CANDIDATES

Display on departmental website and Notice Board.

### CLASS COMMENCEMENT

Display on departmental website and Notice Board.

**06**

# COURSE PLAN

## COMPULSORY

(Per Course 3 Credit Hours)

ME-521 Automation & Control  
 ME-522 Computer Aided Manufacturing  
 ME-523 Operations Research  
 ME-524 Reliability & Quality Engineering  
 ME-525 Advanced Manufacturing Processes  
 TE-505 Advanced Statistics



## ELECTIVES

(Per Course 3 Credit Hours, except mentioned)

ME-503 Computer Aided Design  
 ME-504 Finite Element Analysis  
 ME-511 Materials Science  
 ME-526 Advanced Metal Forming  
 ME-527 Human Factor Engineering  
 ME-528 Computer Integrated Manufacturing  
 ME-529 Management Information System  
 EM-504 Project Management Framework &  
 Tools  
 MS-552 Applied Mathematics II  
 MS-553 Computer Applications (0 Credit Hr)  
 IM-505 Automated Manufacturing Systems  
 IM-506 Business Process Reengineering  
 IM-513 Six Sigma Methodologies  
 IM-515 Agile & Lean Manufacturing  
 IM-525 Design for Manufacturing  
 IM-526 Facilities Planning & Layout  
 IM-527 Intelligent Manufacturing Systems  
 ME-586 Health Safety & Environment  
 SE-512 Research Methodology (0 Credit Hr)  
 IM-5002 Thesis (6 Credit Hrs)



*"If you define the problem correctly, you almost have the solution"*  
 (Steve Jobs)



# FEE STRUCTURE

## Fee Payable at the time of admission to the Programme

Admission / Re-admission Fee

(Enrolment fee (along with form fee)

Security Deposit

Documents Verification Fee



## Fee Payable in each semester

Tuition & Examination Fee per Course

Library Fee

Registration Fee/Semester

Internet Fee

Late Fee, if applicable

Equivalence Fee, if applicable

University Endowment Fund

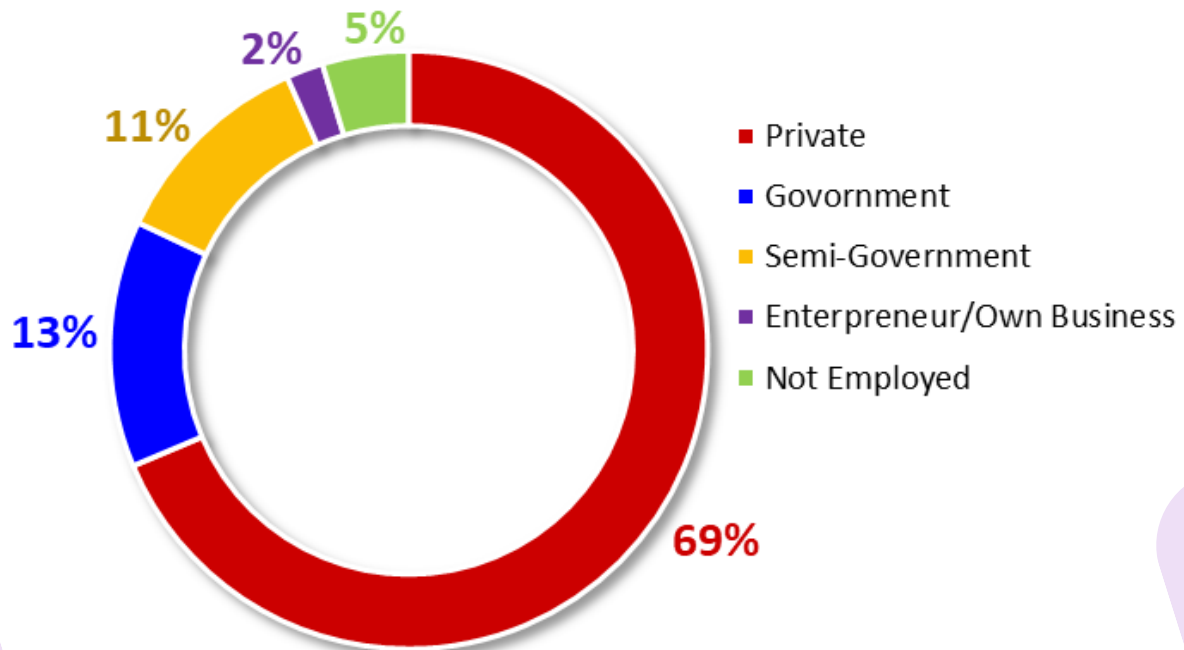
I-Grade Examinations Fee, if applicable



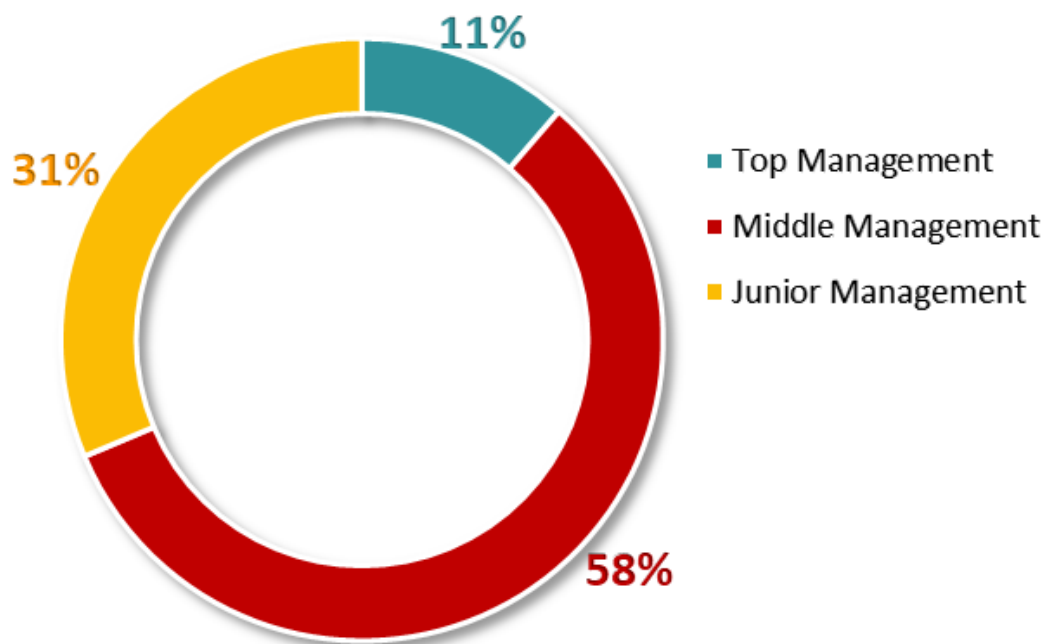
**ACADEMIC CALENDER**  
Availabe at University  
Website

# ALUMNI / STUDENTS STATISTICS

Alumni/Students representation by Organisation



Alumni/Students representation by Level of Management

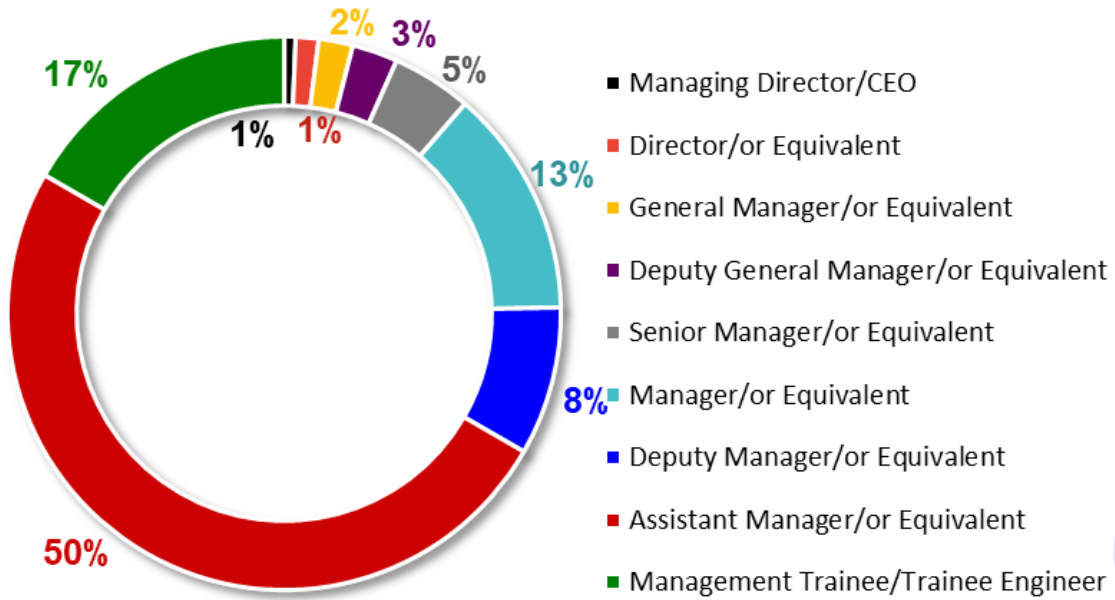


*"It's fine to celebrate success but it is more important to heed the lessons of failure"*  
(Bill Gates)

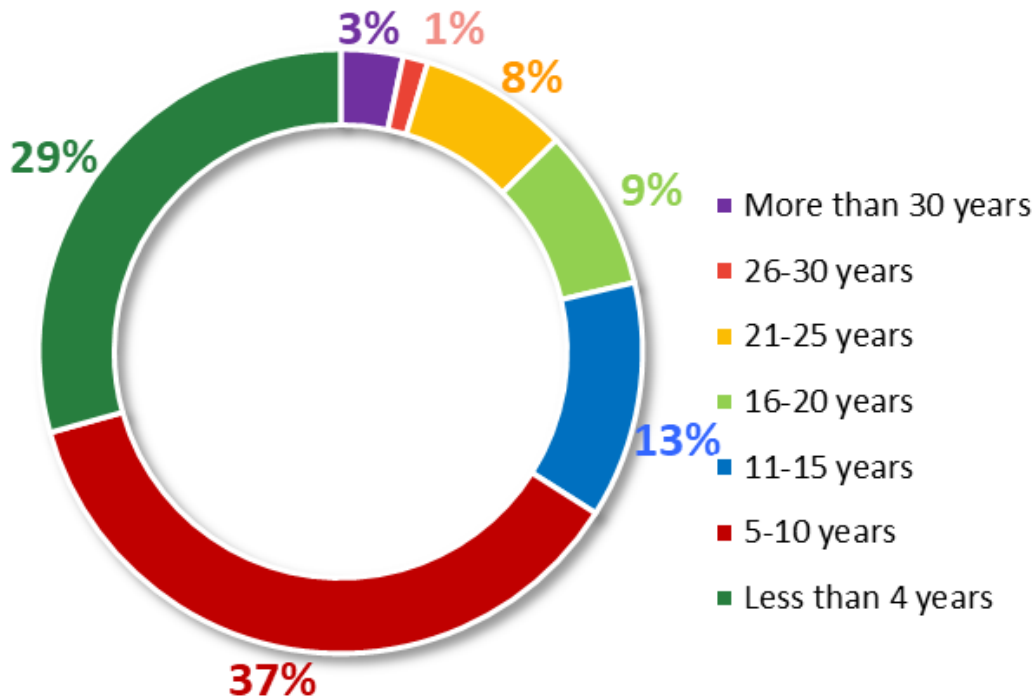
\* Statistics is based on the Sampled Data from 1st batch to present

# ALUMNI STATISTICS

## Alumni/Students representation by Designation



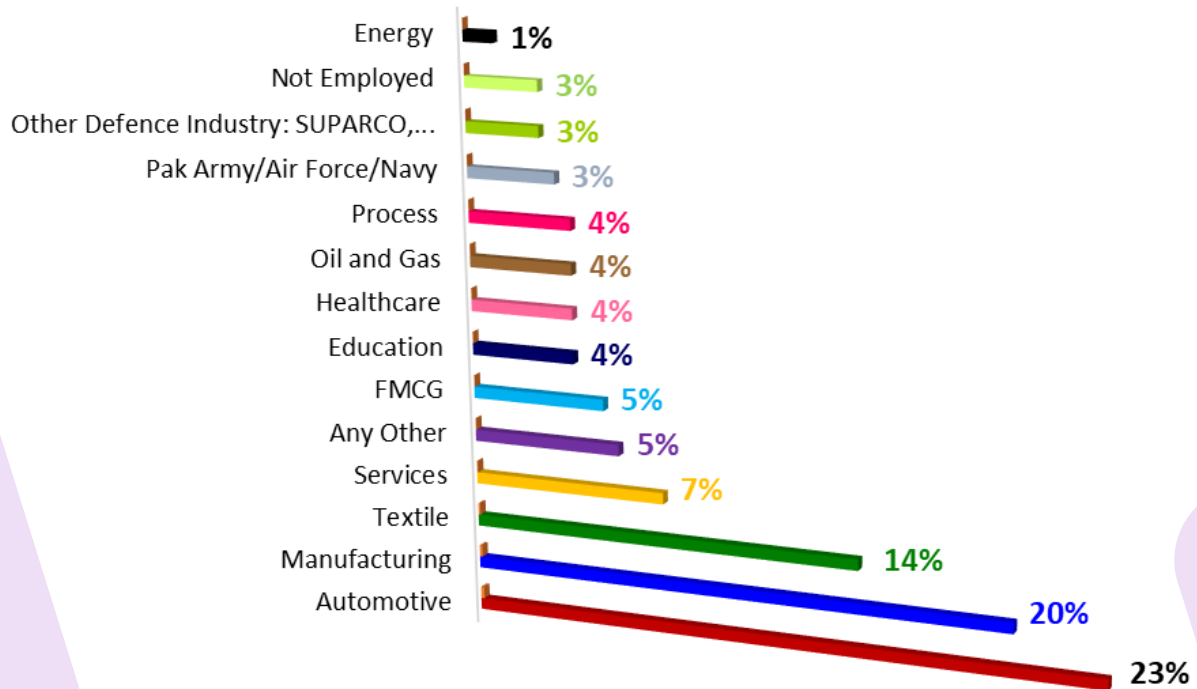
## Alumni/Students representation by Field Experience



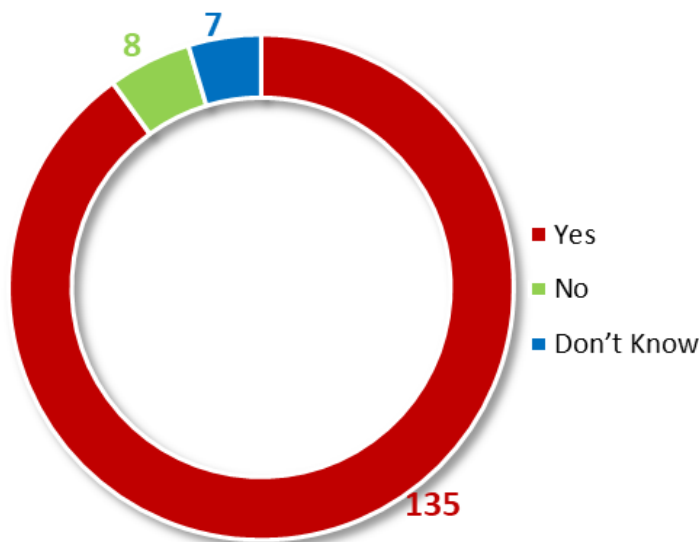
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# ALUMNI STATISTICS

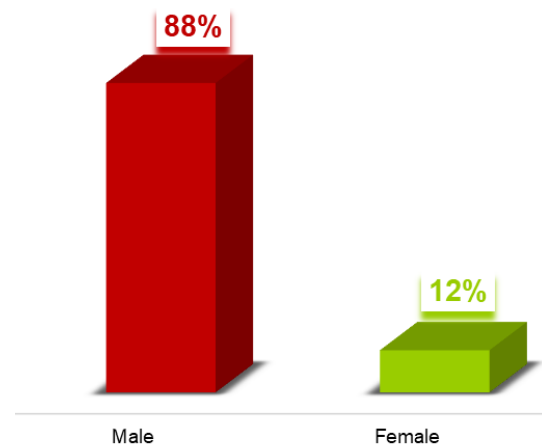
## Alumni/Students representation by Types of Organisation



## Alumni/Students representation by Recommendation for IMD Master Degree Prog.



## Male/Female Ratio



*"Leadership is not rank, privileges, titles, or money; it is responsibility"*  
 (Peter F. Drucker, educator and business management thinker)

\* Statistics is based on the Sampled Data from 1st batch to present

# TESTIMONIALS

” **KASHIF RAHIM** *General Manager Indus Motor Company Limited*

Enrolling in the industrial and management master's degree program, it was an immensely rewarding experience. The rigorous curriculum not only provided a profound understanding of industrial processes but also equipped me with advanced management skills crucial for today's dynamic business landscape. The faculty, and experts in their respective fields, fostered an environment of intellectual curiosity and encouraged practical application of theoretical concepts. Overall, this master's program has been instrumental in shaping my holistic understanding of industrial processes and management practices, providing a solid foundation for a successful and fulfilling career in the field.

“

” **KHAN ASIF KAMAL** *Dy. General Manager - AEWL*

I'm thinking of making a career boost and the NED University Master Degree Programme helps. NED University of Engineering & Technology is one of the oldest and most prestigious engineering institutions in Pakistan. It gives the skills and knowledge to design, develop, implement, and improve Manufacturing Systems and processes in the industry. Not only but also to have the ability to apply ethical and professional standards. The faculty are knowledgeable and supportive. I am very satisfied with M. Engg. Programme and I think it is worth the investment.

“

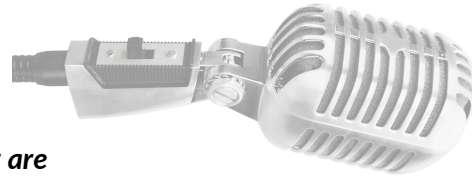
” **ZUBAIR AHMED** *Manager Tecno Pack Industries*

I completed my master's degree program and I can confidently say that it was one of the best decisions of my life because after completion I was promoted to a manager position and also assigned the role of Management Representative for the organization. The program offered me a comprehensive and rigorous curriculum that covered both theoretical and practical aspects of the field. The faculty members were highly qualified and experienced, and they always encouraged me to explore new ideas and challenge myself. The program also provided me with ample opportunities to work on real-world projects, collaborate with industry partners, and network with peers and mentors. I learned a lot from the program and I feel well-prepared for my future career. I would highly recommend this program to anyone who wants to pursue a master's degree in Quality Management who is working in any automotive or manufacturing organization

“

# GUEST SPEAKER SESSIONS

Few of them latest are



SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Dr. Haider Anwar**  
 Associate Professor  
 Mechanical Engg. Department

**TOPIC: "RESEARCH METHODS IN ENGINEERING MANAGEMENT"**

DATE: Sunday 24th December 2023  
 TIME: 10:00 AM - 11:30 AM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Total Quality Management

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Syed Haseeb Hassan**  
 Sales Manager - EM Charging Infrastructure  
 ABIE E-mobility GmbH, Germany

**TOPIC: PRODUCT & VALUE CREATION**

DATE: Tuesday 19th December 2023  
 TIME: 7:00 PM - 8:00 PM

ORGANISED BY  
 Prof. Dr. Ing. Mushtaqul Hassan Hashim in coordination with  
 The Department of Industrial & Manufacturing Engineering  
 Subject: New Product & Service Development Management

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Mr. Khurshand Iqbal**  
 SITE Director  
 GlaxoSmithKline

**TOPIC: HEALTHY & ENVIRONMENT SAFETY**

DATE: Tuesday 19th December 2023  
 TIME: 7:00 PM - 8:30 PM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Health, Safety and Environment

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Dr. Sharfuddin Ahmed Khan**  
 Assistant Professor  
 University of Regina, Canada

**TOPIC: DIGITALIZATION AND SUPPLY CHAIN MANAGEMENT: BENEFITS, CHALLENGES AND OPPORTUNITIES**

DATE: Friday 29th December 2023  
 TIME: 8:00 PM - 9:00 PM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Supply Chain Management

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Syed Saad Anwar**  
 Head of Business Development  
 Lucely Water Corporation

**TOPIC: "STRATEGIC PLANNING & DECISION MAKING"**

DATE: Friday 22nd December 2023  
 TIME: 7:00 PM - 8:30 PM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Strategic Planning & Decision Making

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Muhammad Azam**  
 Senior Manager Operational Excellence  
 +92-338-8819415

**TOPIC: "LEAN MANUFACTURING & IMPLEMENTATION CHALLENGES"**

DATE: Friday 22nd December 2023  
 TIME: 7:00 PM - 8:30 PM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Agile & Lean Manufacturing

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Mr. Ahmed Saad Quresh**  
 Manager Outsourcing  
 HBI

**TOPIC: LOGISTICS MANAGEMENT**

DATE: Wednesday 20th December 2023  
 TIME: 7:00 PM - 8:30 PM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Logistics Management

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Taha Bin Mehmood**  
 Principal Engineer - Solution Engineer  
 Octopus Digital

**TOPIC: MAINTENANCE MANAGEMENT**

DATE: Wednesday 20th December 2023  
 TIME: 6:30 PM - 8:00 PM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Maintenance Management

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Mr. Hassan Ahmed Memon**  
 Manager, Strategy and Plan  
 EasyPosix - Telecom, Mktg to Fintech

**TOPIC: THE IMPORTANCE OF MARKETING FOR ENGINEERS!**

DATE: Thursday 23rd December 2023  
 TIME: 7:00 PM - 8:30 PM

ORGANISED BY  
 Mr. Yasir Ali Mehmood in coordination with  
 The Department of Industrial & Manufacturing Engineering  
 Subject: Principles of Marketing

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Syed Muhammad Osama Iqbal**  
 Executive Manager Planning  
 Hiltal Foods Limit

**TOPIC: SUPPLY CHAIN MANAGEMENT**

DATE: Sunday 24th December 2023  
 TIME: 3:00 PM - 4:30 PM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Supply Chain Management

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Abdullah Ansari**  
 Operational Technology Manager  
 Pfizer, Australia

**TOPIC: PROJECT MANAGEMENT**

DATE: Thursday 28th December 2023  
 TIME: 7:30 PM - 9:00 PM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Project Management

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Mr. Nisar Ahmed Soomro**

**TOPIC: "INCOME TAX PRINCIPLES & PRACTICES"**

DATE: 9th December 2023  
 TIME: 6:30 - 09:00 PM

ORGANISED BY  
 Mr. Saqar Uddin in coordination with the Department of Industrial & Manufacturing Engineering  
 Subject: Accounting & Financial Management

SESSION ON GUEST **SPEAKER**  
 Series of Guest Speaker Sessions  
 Master Degree Programmes  
 By **Dr. Sharfuddin Ahmed Khan**  
 Assistant Professor  
 University of Regina, Canada

**TOPIC: DEVELOPMENT OF A QUALITY PAPER AND HOW TO PUBLISH IN TOP JOURNAL**

DATE: Saturday 23rd December 2023  
 TIME: 8:00 PM - 9:00 PM

ORGANISED BY  
 Department of Industrial & Manufacturing Engineering  
 Subject: Research Methods in Engineering Management

*"An investment in knowledge pays the best interest"*  
 (Benjamin Franklin)

# CONTENTS OF COURSES

## COMPULSORY:

**ME 521 Automation & Controls:** Production Operations & Automation Strategies: Automation defined; types of automation; reasons for automation; manufacturing industries; types of production; functions in manufacturing; organization & information processing in manufacturing; plant layout; production concepts & mathematical models; automation strategies. Automotive Type Automation: Automated flow lines; methods of work part transport; transfer mechanism; buffer storage; control functions; automation for machining operations; design & fabrication considerations; general terminology & analysis; analysis of transfer lines without storage; partial automation; automated flow lines with storage buffers; computer simulation of automated flow lines. Assembly Systems & Line Balancing: The assembly process; assembly systems; manual assembly lines; the line balancing problem; methods of line balancing; computerized line balancing methods; flexible manual assembly lines; types of automated assembly systems; parts feeding devices; analysis of multi-station assembly machines; analysis of a single station assembly machine. Computer Assisted Optimal Control: Structural model of a manufacturing process; steady state optimal control; adaptive control; on line search strategies.

**ME 522 Computer Aided Manufacturing:** Conventional Numerical control: Introduction, basic components of an NC system, the NC procedure, NC coordinate systems, NC motion control systems, applications of numerical control, economics and justification. NC Part Programming: Punched tape in NC, tape coding and format, manual part programming, computer assisted part programming, the APT language, NC programming with interactive graphics, voice NC programming, manual data input, APT word definitions. Computer Controls in NC: Problems with conventional NC, NC controller technology, computer numerical control, direct numerical control, adaptive control machining systems, trends and new developments in NC. Group Technology and FMS: The role of group technology in CAD / CAM integration; methods for developing part families; classification and coding: hierarchical code, attribute code, hybrid code, selecting a coding system, development your own coding system; coding systems: OPITZ coding system, MICLASS coding systems; facility design using group technology; cell design; economic modeling in a group technology environment: production planning cost model, group tooling economic analysis; economics of group technology: benefits in design, benefits in manufacturing, benefits to management, group technology advantages/disadvantages summarized. Introduction to FMS, FMS workstations, materials handling and storage system, computer control system, planning the FMS, analysis methods for FMS, application and benefits. Process Planning: The role of process planning in CAD / CAM integration, Approaches to process planning: Manual approach, Variant approach, Generative approach; Process planning systems: CAM-I automated process planning (CAPP), DCLASS, Computer Managed process planning (CMPP), Machinability data system.

**ME 523 Operations Research:** Linear Programming: Formulation, graphic solution, assumptions of LP, The simplex method, equality constraints, inequality constraints, negative RHS, duality theory, primal and dual problems. Special Types of LP Problems: The transportation problem, production scheduling, North-west corner rule, Vogel's approximation method, Russell's method, transshipment problem, assignment problem, goal programming, sensitivity analysis, parametric programming, dynamic programming, integer programming. Queuing Theory: Basic queuing process, the birth and death process, basic model with infinite and finite queue, limited input source, priority queuing model. Inventory Control Theory: Deterministic models: continuous review-uniform demand, shortages permitted, quantity discount- shortages not permitted. Stochastic Models: Single- period model with no setup cost, model with initial stock level, single- period model with setup cost, two-period inventory model with no setup cost.

# CONTENTS OF COURSES

**ME 524 Reliability & Quality Engineering:** Reliability Measures: The reliability function; expected life; failure rate and hazard function; reliability and hazard function for well known distributions such as exponential; normal, log normal, Weibull, and gamma distributions; hazard models and product life; constant hazard function, linearly increasing hazard function, piecewise linear bathtub hazard function, power function model, exponential model. Static Reliability Model: Series system, parallel system, series & parallel combinations, complex system analysis, reliability considerations in design. Reliability Engineering Design: Reliability design methodology, strength and stress distributions, safety factors and reliability, reliability bounds in probabilistic design. Transformation of random variables. Sums and differences of normal random variables, error analysis, statistical tolerancing. Interference Theory and Reliability Computations: General expression for reliability; reliability computations for normally, log normally, exponentially, Gamma and Weibully distributed stress and strength; reliability design examples. Reliability in Design and Testing: Dynamic reliability models, reliability estimation, sequential life testing, Bayesian reliability in design and testing, reliability optimization. Control Charts: Properties of the distribution of sample means, sample range estimation of standard deviation, chance and assignable causes, control charts for mean & range, control charts for mean & standard deviation, control charts for proportion defective & defects per assembly. Tests of significance to compute confidence limits. Acceptance Sampling: Introduction, OC curve, consumer & producer risks, AQL & LTPD, Acceptance Sampling for continuous production, Acceptance by Variables, Single, Double, & Sequential Sampling. Quality, Reliability, & Maintainability: Definitions, management of quality control, economic aspects of quality decisions, capability & variability analysis, various aspects of life testing, reliability, & maintainability, Introduction to ISO 9000, and ISO 14000.

**ME 525 Advanced Manufacturing Processes:** Mechanics of Orthogonal & Oblique Metal Cutting: Chip formation; thin-zone and thick-zone models for analysis; prediction of forces. Rake angle in oblique cutting; shear angle; velocity relationships; force and stress relationships; shear angle and chip flow direction measurement; strain and strain rate. Temperatures in Metal Cutting, Cutting Fluids and Surface Finish: Heat generation in metal cutting; effect of cutting speed on temperatures; measurement of cutting temperatures; cutting fluids: effects of cutting fluids; assessment of cutting fluid cooling effectiveness; fluid film lubrication; boundary lubrication; characteristics of an efficient lubricant; selection of cutting fluids; theoretical roughness in turning, drilling, milling, & grinding; measurement of roughness; average values of roughness for various manufacturing processes. Tool Life & Tool Wear: Application of wear theories to tool wear; adhesion, abrasion, & diffusion wear; forms of wear in metal cutting; crater wear, & flank wear; variables affecting tool life; Taylor's tool life equation; generalized tool life equation; methods of tool life testing data. Economics of Metal Cutting: Application of minimum cost per piece, maximum production rate, and maximum profit rate criteria in turning, milling, drilling, and shaping operations. Non Traditional Machining Processes: Principle of EDM, operation of tool feed, tool wear and tool materials, dielectric fluid, nature of machined surfaces, metal removal, accuracy, wire cut (EDM), principle of ECM, electrolyte, metal removal rate, nature of machined surface, efficient of tool feed and supply voltage on accuracy, tool shape correction, electrochemical grinding, chemical milling, ultrasonic machining, laser beam machining, electron beam machining, electrochemical deburring, abrasive jet machining, plasma arc machining.

*"If management thinks people don't care, it's likely that people won't care"*  
 (F. James McDonald, former president and CEO of General Motors)



# CONTENTS OF COURSES

**TE 505 Advanced Statistics:** Probability Distributions & Transformation of Variables: Uniform, binomial, hyper geometric, poisson. Normal, exponential, chi-square, F, & T distributions; random sampling; sampling distribution of mean; central limit theorem. Statistical Inference & Hypothesis Testing: Confidence & significance level; sample size determination; point & interval estimates; interval estimates for population mean, population standard deviation, & population proportion. Type I, & Type II errors; one tail & two tail tests; tests concerning means & variances. Linear & Multiple Linear Regression & Correlation: Simple linear regression; properties of least square estimates; confidence limits & tests of significance; choice of a regression model; correlation. Estimating the coefficients; adequacy of the model. Analysis of Variance: One way classification; tests for the equality of several variances; single degree of freedom comparisons; multiple range test; comparing treatment with a control; comparing a set of treatments in blocks; randomized complete block design; random effects model. Factorial Experiments: Two-factor experiments; interaction in two-factor experiments; two-factor analysis of variance; three-factor analysis; choice of sample size. 2K Factorial Experiments: Yate's technique for computing contrasts; factorial experiments in incomplete blocks; fractional factorial experiments; analysis of fractional factorial experiments.

## ELECTIVES:

### **ME 503 Computer Aided Design (CAD):**

Fundamentals of CAD: Introduction, the design process, application of computers for design, creating the manufacturing data base, benefits of CAD. Computers, input / output devices, storing an image. Geometric Modeling: Geometric Modeling Techniques: multiple-view two dimensional input, wire frame geometry, surface models, Geometric Entities: points lines, surfaces, solids, tessellated modeling, Cubic Curves: Hermite curves, Bezier curves, B-spline curves, Bicubic Surfaces: Hermite surfaces, Bezier surfaces, B-spline surfaces. Solid Modelers: solid modeling construction technique: pure primitive instancing (PPI), spatial occupancy enumeration (SOE), cell decomposition (CD), sweeping (S), constructive solid geometry (CSG), boundary representation (BREP), Euler formula, solid modeler storage data bases, feature recognition, feature-based design using CSG construction, using a BREP for part interpretation; data transfer standards. computer graphics: Computer Graphics and the Part Model: Interactive graphics, graphics in CAD, two-dimensional graphics, two-dimensional transformations, three-dimensional graphics, three-dimensional transformations, composite transformations in three dimensions, projections, realistic image generation. Concurrent Engineering: Key definitions; driving forces behind concurrent engineering; the meaning of concurrent engineering; schemes for concurrent engineering: axiomatic design, DFM guideline, design science, design for assembly, the Taguchi method for robust design, manufacturing process design rules, computer-aided DFM, group technology. Failure mode and effects analysis, summary of concurrent engineering tools.

# CONTENTS OF COURSES

**ME 504 Finite Element Analysis:** FEA of One-Dimensional Problems: Introduction, basic steps in FEA; modeling, discretization, connectivity of elements, imposition of boundary conditions, solutions & post processing; applications to heat transfer, fluid mechanics, & solid mechanics problems. Bending of Beams: Euler-Bernoulli beam element, governing equations, application of FE on beam, beam examples, plane truss element, frame element, Timoshenko beam & frame element, inclusion of constraint equations. Finite Element Error Analysis: Approximation errors, various measures of errors, convergence of solutions, accuracy of solutions. Numerical Integration & Computer Implementation: Isoparametric formulations, numerical integrations, natural coordinates, computer implementation (pre-processor, processor, post-processor). FEA of Two-Dimensional Problems: Introduction, single variable problems; boundary value problems; model equations, discretization, weak form, finite element model, assembly, solutions & post processing; mesh generation; imposition of boundary conditions; applications; parabolic equations; hyperbolic equations. Interpolating Functions, Numerical Integration & Modeling Considerations: Interpolating techniques; triangular, rectangular, & serendipity elements; coordinate transformation; integration on a master element; modeling, mesh generation, load representation. Plane Elasticity: Assumptions of plane elasticity; basic equations, weak formulations; principle of virtual displacement in matrix form; finite element model, matrix & weak form model; evaluation of integrals. Bending of Elastic Plates: Classical plate model; finite element model; shear deformable plate model; displacement field, virtual work statement; shear locking & reduced integration; introduction to time dependent problems; computer illustrative examples.

**ME 511 Materials Science:** Polymeric Material: High performance fiber, high performance elastomers, high performance coatings, special polymers, moderately high polymers, engineering polymers. Materials development and modification, multilayer and adhesive technology will also be part of this course. Physical and chemical testing of polymers. Fundamentals of Polymers: Molecular structure, polymerization processes, morphology of polymer molecules, plasticisers and fillers. Composition and characteristics of principal types of polymers, convention constant rate of elongation test, creep tests, isochronous curves and other forms of data presentation, strain recovery and stress relaxation, anisotropy of properties time-dependence of strength and creep rupture, durability under cyclic loading BS impact tests. Fracture of Polymers: Fundamentals of fracture mechanics, application of fracture mechanics to polymers, KC determinations, KC crack speed curves instability, environmental effects impact testing, application to practical problems. Composites: Composite materials compared with conventional materials, fiber and matrices, composite mechanics, elastic properties, failure processes, failure at notches, notch sensitivity and fracture energy. Fatigue and failure of composite materials. Deterioration of properties owing to environmental conditions, hybrid composite materials, manufacturing the by hand lay-up, preparing specimen for mechanical testing, burn off tests to determine fiber volume fracture. Categories of Composites. Properties of glass and other fibers. Matrix materials composites as monotropic membranes. Mathematical models of stiffness of composites based on mechanics of materials and energy considerations. Elasticity of anisotropic materials. Strength of composites. Outline of methods of manufacturing composites and of their applications.

*"It is not the employer who pays the wages. Employers only handle the money. It is the customer who pays the wages"*  
(Henry Ford)

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**ME 526 Advanced Metal Forming:** Macroscopic Plasticity & Yield Criteria: Tresca, & Von Mises criterion; plastic work; effective stress; effective strain; flow rules for plastic stress-strain relations; principle of normality. Work Hardening & Plastic Instability: Tensile test; mechanical properties; nominal & true stress-strain curves; work hardening expression; behavior after necking; direct compression; bulge test; plane-strain compression test. General approach to instability; balanced biaxial tension; thin-walled sphere internal pressure; significance of instability. Strain Rate & Temperature: Strain rate; Superplasticity; combined stress and strain-rate effects; strain rate dependence; temperature dependence of flow stress; hot working; temperature rise during deformation. Ideal Work: Ideal work or uniform energy; extrusion & rod drawing; friction; redundant work, and mechanical efficiency; maximum drawing reduction. Slab Analysis: Sheet drawing; comparison of slab method & ideal work method; wire drawing; direct compression in plane strain; average pressure during plane-strain compression; sticking friction; axisymmetric compression; flat rolling. Bending: Springback in sheet bending; bending with superimposed tension; sheet bendability; bending of sheets & tubes; forming limits in shape bending. Cupping, redrawing, and ironing cup drawing; effects of work hardening; deformation efficiency; effects of tooling; redrawing; ironing. Complex Stamping: Localized necking in biaxial stretching; formability; forming limit diagrams; cupping tests; edge cracking; bulk forming tests.

**ME 527 Human Factor Engineering:** Introduction: Scope of ergonomics, human operator as system components; physical size and shape dynamics, Anthropometry, sources and application of energy input sensitivity, central processing capacity, input characteristics, environmental effects, heat and vibration, lightning and noise. Techniques in human factor studies; the assessment of physical activity, subjective assessment technique, methods of work analysis. Design Requirements: Interface design; space requirements and layout visual presentation of information, auditing presentation of information, machine dynamics, control design, environmental factors, jobs aids, System evaluation.

**ME 528 Computers Integrated Manufacture:** Fundamentals of CIM: Definition of CIM, technology issues: the one-model concept, configuration management, data base management systems, network, distributed data base systems, management of technology, other emerging issues; fundamentals of networking: network concepts, OSI / MAP / TOP. Integrative Manufacturing Planning & Control: Overview of manufacturing engineering; overview of production control: forecasting; master production schedule; rough-cut capacity planning; material requirements planning; capacity planning; order release; shop-floor control; quality assurance; manufacturing planning and control systems, cellular manufacturing: overview; hierarchical manufacturing control model, JIT manufacturing philosophy.

**ME 529 Management Information Systems:** Management Information System Concepts: What a System is, Information System Defined, Computer Based Information System, Functions of an Information System, Manager and information needs, the role of managers, management levels and information needs. Types of Information Systems: Transaction processing systems, management information systems, decision support systems, executive support systems. The System Development Life Cycle: Reasons to develop new information systems, system analysis, problem definition, requirements analysis, project justification, system analysis tools, system design, logical design stage, system design tools, prototyping and its effects on the system development life cycle, automating system analysis and design, system implementation, testing and installation stage, training stage, and system maintenance. File and Database Processing: File processing, file management systems, database processing, database management systems, database models: the hierarchical model, the network model, the relational model, object-oriented model, database design considerations. Managing database: distributed databases, knowledge-based systems. Expert system shells, knowledge engineering, uses of knowledge-based systems.

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**EM 504 Project Management Framework and Tools:** Role of projects in organization's competitive strategy; Standard methodologies for managing projects; project life cycle; design-implementation interface; estimating: preliminary and detailed; contractual risk allocation; scheduling: PBS; WBS; integration of scope, time, resource and cost dimensions of a project; evaluation of labor, material, equipment, and subcontract resources; scheduling techniques including CPM/ PERT, GERT, critical chain; solving real-world project schedules; Monte Carlo simulation; cost budgeting; cost baseline; cash flow analysis; earned value analysis; cost control; proposal presentation; application of software for project management (MS Project, Primavera Project Planner-P3).

**MS 552 Applied Mathematics-II: Analysis of Variance:** One-way classification; Tests for the equality of several variances; single degree of freedom comparisons; multiple range test; comparing treatment with a control; comparing a set of treatments in blocks; randomized complete block design; random effects model. Factorial Experiments: Two-factor experiments; Interaction in two-factor experiments; two-factor analysis of variance; three-factor analysis; choice of sample size. 2K Factorial Experiments: Yate's technique for computing contrasts; factorial experiments in incomplete blocks; fractional factorial experiments; analysis of fractional factorial experiments.

**MS 553 Computer Applications:** Hardware: Basic structure of a digital computer; CPU; types of memory; input/output section; data representation; binary numbering system; peripheral devices. Software: Computer programming languages; machine language; high level languages; operating systems; virtual storage; time sharing; distributed processing. Role of Computers in Engineering: Applications of computers in engineering problems including design and simulation. Use of computer aided engineering software & mathematical modeling. Hierarchy of computers; Local area networks; manufacturing automation protocol; management information system; manufacturing data base; functions of a manufacturing organization; hierarchical computer control concept.

**IM 505 Automated Manufacturing Systems:** Automated flow lines; Methods of work part transport; Transfer mechanism; Buffer storage; Control functions; Automation for machining operations; Design and fabrication considerations; General terminology and analysis; Analysis of transfer lines without storage; Partial automation; Automated flow lines with storage buffers; Computer simulation of automated flow lines. The assembly process; Assembly systems; Manual assembly lines; The line balancing problem; Methods of line balancing; Computerized line balancing methods; Flexible manual assembly lines; Types of automated assembly systems; Parts feeding devices; Analysis of multi-station assembly machines; Analysis of a single station assembly machine. Schemes for Concurrent Engineering: Axiomatic Design, DFM Guidelines, Design for Assembly, The Taguchi Method for Robust Design, Manufacturing Process Design Rules, Computer-Aided DFM, Group Technology; Failure-Mode and Effects Analysis. Robot motions, Robot drive power, Types of robots; Robot motions: Link geometries, Frame of reference, Orientation, Changing frames of reference, Workspace Descriptions; Robot accuracy and repeatability; Economic justification of Robots; Characteristics of robot applications; Robot Cell design; Types of robot applications, Material handling applications; Processing applications; Assembly & inspection.

*"Growth and comfort do not coexist"*  
(Ginni Rometty, CEO of IBM)

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**IM 506 Business Process Reengineering:** Fundamentals of process management; importance of process decisions and process choices; strategic process decisions for manufacturing and service environments. Costs, quality, and timeliness as the primary attributes of value; creation of value through strategies and processes. Process improvement tools and frameworks; process maps, value stream mapping, service blueprinting, reengineering, Poka-Yoke, lean systems and six-sigma. Simulation and modeling of discrete event systems and processes; random numbers generation, Monte-Carlo simulation, and probability distributions for discrete event processes. Implementing BPR methodology; initiating organizational change; building the reengineering organization; identifying BPR opportunities, understanding existing processes, reengineering processes, blueprinting new business systems, performing transformation.

**IM 513 Six Sigma Methodologies:** Introduction to Six Sigma, Internal & External Customers, DMAIC (Define, Measure, Analyze, Improve, Control) cycle, six sigma goals and metrics, six sigma training, six sigma teams, green; black and master black belt, design for six sigma, DMADV (Define, Measure, Analyze, Design, Verify), case studies.

**IM 515 Agile and Lean Manufacturing:** Introduction to Lean Manufacturing, value concept, lean objectives & tools, origins of lean systems, group technology, 5S, single minute exchange of dies, total productive maintenance, Kaizen, Just-In-Time Manufacturing Systems, Push & Pull Manufacturing Systems, Poka-Yoke, Toyota production system, introduction to agile manufacturing, research projects in agile manufacturing, design of market responsive supply and distributions manufacturing systems.

**IM 525 Design for Manufacturing:** Concepts of design for manufacturing (DFM), role of DFM in product specification and standardization, design, development, and functional requirements, material and process selection. Introduction to components of DFM – design for assembly, performance, quality, bio-compatibility, ergonomics, recycling, etc. Design to Cost. Quantitative methods of material selection in DFM based on engineering properties, material performance indices, comparative property charts, costs, etc., Evaluation of single and multi-attribute utilities. Design rules for selection of materials and processes, Part geometry and tolerances, shape factor, prototyping, computer-aided material and functional modeling, mathematical optimization, formation of objective and constraint functions, factorial analysis. Case studies on product design for manufacturing and assembly.

**IM 526 Facilities Planning and Layout:** Introduction to Product and Process Design, process planning and sequencing; manufacturing processes: automation with respect to sensing equipment and control systems; manufacturing systems: fixed and flexible manufacturing systems, single-stage multi-machines systems, Just in time and group technology approach; requirements and selection of machines and labour, building, organization, communications and support requirements; material handling principles: equipment and its selection criteria, flow lines, grouping, packaging, storage and warehousing, plant and office layout: conventional approaches, flow space and activity relationships, computerized layout planning models and algorithms, computer aided process planning, operation sequence and path planning with constraints, case studies in CAPP, simultaneous development of plant layout and material handling systems, basic facility location problems, single- and multiple facility placement problems, heuristics and computerized approaches.

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**IM 527 Intelligent Manufacturing Systems:** Intelligent Manufacturing Systems; Architecture, basic building blocks, knowledge modeling and representation; rule based and fuzzy logic systems, artificial neural networks; perception model, network architectures, pattern recognition and machine vision, learning methodologies; back propagation algorithm; genetic algorithms, techniques for intelligent shop floor control, flexible manufacturing systems, intelligent process monitoring and control using PLCs, integration of robots in intelligent manufacturing systems.

**ME-586 Health, Safety and Environment:** Safety management, OSHA protection program, management systems, equipment safety, fire protection and life safety, combustion and flammability, process and system safety, system reliability, material handling, operations safety, construction safety, chemical hazard assessment, material safety datasheets, exposure limits, hazard communication, personal protective equipment, industrial ventilation, radiation safety, sound and hearing conservation. Types of pollution and prevention, Air emissions modeling, air sampling methods, waste treatment (physical, chemical, biological thermal types) and disposal technologies, wastewater and water treatment, water quality standards, water discharge limitations and standards, pretreatment regulations, storage and containment.

**SE-512 Research Methodology (0 Credit Hr)**

**IM-5002 Thesis (6 Credit Hrs)**

*"What is our business?" is not determined by the producer but by the customer "  
(Peter Drucker*