IARE
INSTITUTE OF
AERONAUTICAL ENGINEERING

# ENHANCING SKILLS THROUGH INDUSTRY-RELEVANT LEARNING AND INNOVATION

# MINI COURSES HANDBOOK

**ACADEMIC YEAR 2026–27**

Institute of Aeronautical Engineering
Dundigal, Hyderabad – 500 043 | www.iare.ac.in | Education for Liberation

# INDEX

## Foreword

In today's rapidly evolving technological landscape, continuous learning has become essential for academic excellence, professional growth, and career readiness. Recognizing the need to equip students with emerging skills and industry-relevant competencies, the Institute introduced **Mini Courses for Continuous Improvement (MICC)** as a structured learning initiative.


**Figure: Inception to delivery of MICC course**

The above figure illustrates the systematic process followed for the development and implementation of Mini Courses for Continuous Improvement (MICC), from identifying industry-driven learning needs to course delivery and evaluation. The framework ensures relevance, quality, and continuous enhancement of student learning outcomes

MICC provides students with opportunities to explore advanced topics, contemporary technologies, professional practices, and interdisciplinary domains beyond the regular curriculum. These focused learning modules are designed to bridge the gap between academic instruction and industry expectations while fostering innovation, self-learning, critical thinking, and lifelong learning habits.

The courses offered under MICC are carefully designed by faculty experts in consultation with industry requirements and evolving technological trends. Through hands-on learning, practical applications, case studies, and by using modern tools, students gain valuable exposure that enhances their employability and professional competence.

## Introduction to Mini Courses for Continuous Improvement

Mini Courses for Continuous Improvement are short-duration, focused learning modules designed to complement the regular curriculum by addressing emerging technologies, industry requirements, professional competencies, and advanced academic concepts. It provides students with opportunities to acquire specialized knowledge and practical skills beyond conventional classroom learning.

These courses are developed to bridge the gap between academic education and industry expectations while promoting innovation, self-learning, interdisciplinary exposure, and lifelong learning. Through a flexible and outcome-based approach, it enhances students' employability, technical proficiency, and readiness to meet future professional challenges.

## Objectives:

- Bridge the gap between academic curriculum and evolving industry requirements.
- Provide focused learning opportunities in emerging technologies and specialized domains.
- Enhance technical, professional, and employability skills of students.
- Promote self-learning, innovation, critical thinking, and problem-solving abilities.
- Encourage interdisciplinary learning and exposure to contemporary practices.
- Support continuous improvement and lifelong learning among students.

## Learning Outcomes:

**Upon successful completion of an MICC course, students will be able to:**

- Demonstrate enhanced knowledge and competency in a specific technical or professional domain.
- Apply theoretical concepts to practical and real-world problems.
- Utilize modern tools, technologies, and methodologies relevant to the course area.
- Analyze, evaluate, and solve problems using appropriate techniques and approaches.
- Adapt to emerging trends and pursue continuous learning for career development.

# MICC designing process

The design of MICC begins with identifying emerging industry trends, technological advancements, and skill gaps among students. Based on these requirements, faculty members design and develop courses with clearly defined learning outcomes, course content, and assessment strategies.

The proposed courses are reviewed and approved by the respective head of the department to ensure academic relevance and quality. Once approved, the courses are delivered through a blend of theory, practical sessions, case studies, and modern tools, followed by assessment and feedback for continuous improvement.

## MICC Implementation Framework and Process

The **Course Coordinator / Faculty Mentor** is responsible for designing, delivering, and monitoring the Mini Course for Continuous Improvement.

### The mentor shall:

- Identify relevant and emerging topics aligned with industry needs, professional skills, or advanced academic concepts
- Prepare the course outline, learning objectives, content plan, and assessment strategy
- Guide students throughout the course duration and ensure achievement of stated outcomes
- Conduct assessments and maintain proper academic records

### The Head of the Department (HoD) / Reviewer shall:

- Approve the proposed MICC course content and structure
- Monitor the quality, relevance, and delivery of the mini course
- Ensure alignment of MICC with program outcomes, continuous improvement, and accreditation requirements

### Nature of MICC

- MICC is **not a substitute** for regular courses but an **add-on learning initiative**
- These courses focus on **depth, skill enhancement, and current relevance**
- MICC may include **hands-on sessions, case studies, simulations, tool-based learning, or industry practices**

## MICC Process

### 1. Identification of Course

Faculty members propose MICC topics based on:

- Emerging technologies
- Industry requirements
- Research trends
- Skill gaps identified in students

It shall include:

- Course title
- Objectives
- Learning outcomes
- Course duration
- Assessment method

### 2. Course Delivery

MICC can be conducted through:

- Classroom sessions

- Hands-on laboratory sessions
- Online / blended mode
- Workshops or expert lectures

Students are expected to:

- Attend all sessions regularly
- Actively participate in activities and discussions
- Complete assignments, exercises, or mini tasks

**3. Assessment and Evaluation**

Evaluation may include one or more of the following:

- Assignments / quizzes
- Mini projects
- Case study analysis
- Practical demonstrations
- Presentations

**4. Documentation**

The course coordinator shall maintain:

- Approved course plan
- Attendance records
- Assessment details
- Sample student work
- Outcome attainment report

**Guidelines for Students**

- Participation in MICC reflects the student's commitment to continuous improvement
- Students should choose MICC aligned with their career goals and interests
- Active engagement and self-learning are strongly encouraged
- Completion of MICC can enhance academic profile, internships, and placements

## Department-wise MICC Courses Offerings:

The Department-wise MICC course offerings reflect the institute's commitment to providing specialized learning opportunities aligned with the evolving needs of industry and academia.

Each department offers MICC courses that focus on emerging technologies, advanced technical concepts, professional competencies, and practical applications. These courses enable students to enhance domain-specific knowledge, develop industry-relevant skills, and strengthen their readiness for higher education and professional careers.

**The following departments offer MICC courses:**

1. Aeronautical Engineering
2. Mechanical Engineering
3. Civil Engineering
4. Electrical and Electronics Engineering

## DEPARTMENT OF AERONAUTICAL ENGINEERING

The Department of Aeronautical Engineering is introducing Mini Courses for Continuous Improvement (MICC) to empower students with industry-relevant skills, enhance employability, and prepare them to excel in national and international aeronautical and aerospace industries.

The table shows list of Mini Courses offered in Aeronautical Engineering department

| S.No | Course Code | Course Name | Offered Semester |
|---|---|---|---|
| 1 | MIAEPD01 | SAP Essentials for Aerospace Engineering | IV Semester |
| 2 | MIAEPD02 | 3D - Design and modelling using Solid works | |
| 3 | MIAEPD03 | Surface modelling through CATIA | VI Semester |
| 4 | MIAEPD04 | Aerodynamic flow simulations using ANSYS CFX | |

**Graduates become competitive for opportunities in:**

1. Aircraft & Helicopter OEMs
2. Space Agencies and Satellite Organizations
3. UAV & Defence Start-ups
4. Aerospace MRO and Manufacturing Firms
5. Global Aerospace Consultancies and R&D Centres

## COURSE DETAILS

| | |
|---|---|
| **Course Code** | **MIAEPD01** |
| **Course Name** | **SAP Essentials for Aerospace Engineering** |

## Course Overview

The course focuses on developing hands-on skills in Enterprise Resource Planning (ERP) frameworks customized for the aerospace ecosystem, encompassing material management, production planning, and quality assurance workflows. In today's complex aerospace manufacturing and maintenance domains, employers expect entry-level engineers to navigate digital supply chains and regulatory tracking protocols fluently. This course bridges the gap between academic operations management and professional shop-floor deployment, training students to utilize SAP systems effectively within highly regulated environments. It reflects the operational workflows adopted by global aerospace leaders, defense public sector undertakings, and major Maintenance, Repair, and Overhaul (MRO) organizations, where traceabilty and resource transparency form the backbone of project delivery.

## Professional Context and Industry Skill Demand

Aeronautical Engineering graduates are increasingly recruited into modern lifecycle management roles, including Aerospace Supply Chain Analysts, Logistics Operations Engineers, and Quality Management Specialists. In these capacities, technical professionals must synchronize engineering Bill of Materials (BOM) data with procurement systems and manufacturing schedules under strict AS9100 quality guidelines. This course mirrors established professional workflows practiced across defense installations and commercial assembly facilities. Participants begin with interface navigations and master data architectures, moving into automated procurement cycles, material requirement planning, and digital airworthiness compliance auditing. The focus on transaction precision, strict structural compliance, and material traceability significantly enhances technical capability and process discipline, improving career readiness for global aerospace enterprises and tier-1 aviation suppliers.

## Course Objectives

The objectives of this mini course are to:

I. Provide practical exposure to enterprise resource management workflows customized for aerospace operations using SAP platforms.
II. Enable students to build, maintain, and structure engineering and manufacturing Bills of Materials (BOM) inside an enterprise database.
III. Develop technical competency in managing material requirement planning (MRP) loops and procurement pipelines for aviation components.
IV. Train participants to integrate quality inspection steps and regulatory compliance checkpoints within digital production workflows.
V. Equip students with the analytical skills needed to trace aerospace components across supply chains, from raw metal alloys to operational aircraft structures.

## Course Outcomes

Upon successful completion of this mini course, the student will be able to:

**CO 1**: Demonstrate proficiency navigating the SAP GUI environment and configuring fundamental enterprise master data elements safely.

**CO 2**: Construct and audit hierarchical aerospace components, sub-assemblies, and multi-tier engineering Bills of Materials (BOM).

**CO 3**: Execute comprehensive procurement lifecycles, purchase requisitions, and goods-receipt logs for flight-certified materials.

**CO 4**: Apply automated Material Requirements Planning (MRP) rules to balance manufacturing output with raw component delivery timelines.

**CO 5**: Implement systematic production tracking operations, component reservations, and shop-floor activity logging routines.

**CO 6**: Generate trace documentation, material safety certificates, and quality assurance data sheets conforming to global civil aviation standards.

## Course Content

**Exercise 1**: Enterprise Navigation and User Environment Setup
Familiarization with SAP GUI interface protocols, navigation shortcuts, custom user profile parameters, and security verification logs tailored for aviation engineering data systems.

**Exercise 2**: Material Master Architecture for Aerospace Alloys
Creation and classification of master profiles for specialized materials like titanium and carbon-fiber pre-pregs, maintaining strict aviation serialization and tracking rules.

**Exercise 3**: Engineering and Manufacturing Bills of Materials (BOM)
Structuring multi-tier component hierarchies for structural sub-assemblies, modeling relationships between structural links, fasteners, and internal systems.

**Exercise 4**: Aerospace Supplier Management and Master Records
Building verified vendor files including aerospace quality certificates, AS9100 verification tracking parameters, and commercial delivery agreements.

**Exercise 5**: Purchase Requisition Workflows for Critical Spares
Generating automated and manual procurement requests for structural maintenance components, tracking validation parameters before authorization releases.

**Exercise 6**: Purchase Order Execution and Global Lead-Time Tracking
Converting active requisitions into formal commercial purchase orders, configuring transport tracking parameters for sensitive, time-restricted composite compounds.

**Exercise 7**: Goods Receipt Protocols and Inventory Inspections
Processing incoming stock shipments, updating warehouse counts, and routing components directly to specialized quarantined hold areas for technical verification.

**Exercise 8**: Inventory Controls and Flight-Line Logistics
Managing inventory storage strategies, managing climate-controlled shelving areas, and handling material issues tied directly to specific aircraft tail numbers.

**Exercise 9**: Material Requirements Planning (MRP) Matrix Analysis
Executing multi-level production simulation runs to identify component gaps relative to complex aircraft structural assembly schedules.

**Exercise 10**: Production Order Life Cycle in Aircraft Assembly
Initializing and releasing shop-floor manufacturing cards, tracking processing costs, and assigning engineering task sheets to individual assembly bay locations.

**Exercise 11**: Material Component Staging and Kitting Processes
Allocating component kits and precision hardware attachments to structural assembly lines, maintaining batch tracking logs across all operations.

**Exercise 12**: Aerospace Quality Inspection Operations
Developing quality control tasks embedded in production flows, checking non-destructive test updates, and logging geometric variations.

**Exercise 13**: Non-Conformance Management and Material Dispositions
Processing material variation reports for out-of-tolerance components, managing rework instructions, and archiving salvage approval documents.

**Exercise 14**: Integrated Aerospace Project Audit and Closeout
Executing end-to-end component lifecycle verification, pulling production logs, generating conformity records, and preparing closing financial metrics for the assembly block.

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|---|---|
| **Course Code** | **MIAEPD02** |
| **Course Name** | **3D - Design and modelling using Solid works** |

## Course Overview

The course focuses on developing applied competencies in computer-aided parametric design, structural part modeling, and geometric design validation practices essential for modern aviation and defense development projects. In today's competitive engineering climate, organizations require rapid concept iterations, structural layout efficiency, and accurate weight-distribution reporting before physical prototyping begins. This course bridges the gap between classic technical drawing fundamentals and professional digital product design by training students to create robust 3D component files, complex mechanical assemblies, and production drawings. It reflects the engineering design workflows used across major mechanical consultancies, UAV startups, and structural sub-assembly firms, where parametric solid modeling forms the baseline data source for stress analysis and modern additive manufacturing workflows.

## Professional Context and Industry Skill Demand

Aeronautical graduates regularly transition into functional industry positions such as CAD Design Engineers, Product Support Engineers, and Mechanical Detailers inside tier-1 aerospace design offices. These roles demand professional speed in managing feature trees, isolating component interferences, and updating multi-part configurations dynamically when engineering goals shift. This course structure simulates professional practices followed across leading mechanical and structure drafting hubs. Students progress systematically from 2D geometric constraints and basic solid tools to detailed multi-part assembly trees and engineering drawing formats. The focus on strict model optimization, geometric dimensioning and tolerancing (GD&T) applications, and design consistency boosts practical design confidence, smoothing placement transitions into digital design centers and manufacturing units.

## Course Objectives

The objectives of this mini course are to:

- I Provide practical exposure to parametric design systems and feature-based modeling processes using Solid works environments.
- II Enable students to translate conceptual hand drawings and layout text into fully defined, manufacturing-ready 3D part geometries.
- III Develop technical competency in managing top-down and bottom-up assembly architectures for complex multi-component systems.
- IV Train participants to integrate standard geometric dimensioning and tolerancing (GD&T) annotations onto professional drawing layouts.
- V Equip students with the model evaluation tools needed to calculate mass properties, check interference limits, and fix broken feature trees.

## Course Outcomes

Upon successful completion of this mini course, the student will be able to:

**CO 1**: Demonstrate proficiency in managing the user interface, keyboard shortcuts, and sketch constraints within a modeling workspace.

**CO 2**: Create parametric 3D solid parts using advanced extrusion, revolution, sweep, and loft modification tools.

**CO 3**: Construct structured mechanical assemblies using standard, advanced, and mechanical mating constraint systems.

**CO 4**: Diagnose multi-component assemblies for part interference issues, clearance errors, and mass distribution variations.

**CO 5**: Generate production-ready engineering drawings featuring multi-view projections, section slices, and detailed exploded layout sheets.

**CO 6**: Develop optimized 3D design documentation packages, including automated Bills of Materials (BOM) and structured component portfolios.

## Course Content

**Exercise 1**: Workspace Configuration and Sketched Constraints
Customizing user toolbars, setting engineering units, creating 2D profiles, and applying geometric constraints and dimensions to fully isolate sketch entities.

**Exercise 2**: Extruded and Revolved Base Profiles
Generating standard 3D parts via linear depth extrusions and axis-symmetric revolutions, controlling end conditions and drafting angles.

**Exercise 3**: Applied Applied Engineering Features and Hole Wizard
Utilizing specialized production operations including variable fillets, chamfers, shell walls, and generating standardized counterbore or countersunk holes.

**Exercise 4**: Parametric Patterning and Mirror Systems
Creating linear, circular, and sketch-driven pattern arrays for lightweight arrays, utilizing dynamic mirror tools across planes to minimize duplicate actions.
**Exercise 5**: Swept and Lofted Profile Implementations
Modeling complex guide-rail geometry profiles such as structural stiffener channels, customized pipeline routes, and variable thickness support brackets.

**Exercise 6**: Multi-Body Part Modeling Concepts
Developing isolated solid blocks within a single part file to design interconnected weldments or structural support frameworks efficiently.

**Exercise 7**: Configuration Management and Design Tables
Constructing variations of a baseline part within one file using custom configuration inputs and Microsoft Excel-driven property tables.

**Exercise 8**: Bottom-Up Assembly Creation and Mating Methods
Importing standalone part files into an assembly workspace, establishing positioning via standard coincident, parallel, and concentric mates.

**Exercise 9**: Advanced and Mechanical Joint Modeling
Implementing complex movement constraints including limit distances, profile centers, cam-follower motions, and rotational gear relationships.

**Exercise 10**: Top-Down Assembly Layout and In-Context Parts
Designing new component parts directly within an active assembly environment, referencing existing face profiles to ensure perfect clearance fitments.

**Exercise 11**: Interference Verification and Mass Property Auditing
Running global evaluation sweeps to isolate physical material overlap errors, computing center-of-gravity shifts, and optimization adjustments.

**Exercise 12**: Sheet Metal Component Design
Modeling thin-gauge enclosure elements, establishing custom bend allowances, and exporting flattened patterns for manufacturing tools.

**Exercise 13**: Exploded Assembly Layouts and Animation Tracks
Configuring step-by-step disassembly animations, drawing path lines, and setting up exploded views for technical assembly manuals.

**Exercise 14**: Production Drawing Projections and BOM Integration
Generating complete fabrication prints with projected views, section cuts, detail annotations, and inserting automated Bills of Materials.

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|---|---|
| **Course Code** | MIAEPD03 |
| **Course Name** | **Surface Modelling through CATIA** |

## Course Overview

The course focuses on developing applied competencies in high-precision surface design, wireframe creation, and aerodynamic profile development workflows essential for advanced aerospace structures and high-speed vehicular bodies. In today's engineering space, defining fluid aerodynamic hulls, complex aircraft fuselages, and contoured wing surfaces requires mathematical continuity beyond traditional solid modeling techniques. This course bridges the gap between pure geometric theory and industrial component styling by training students to use advanced surface toolsets to build smooth, organic skins over skeletal wireframes. It reflects the product lifecycle design workflows used by major international aircraft OEMs, defense research laboratories, and automotive styling firms, where high-quality geometric continuity (G0/G1/G2) forms the baseline requirement for wind-tunnel testing and stamping die manufacturing.

### Professional Context and Industry Skill Demand

Aeronautical Engineering graduates aiming for elite design positions are heavily recruited into roles like Aerostructures Design Engineer, Surface Modeler, and Outer Mold Line (OML) Specialist. These specialists are tasked with translating computational fluid dynamic profiles into physical manufacturing surfaces without altering local aerodynamic efficiency. This course content directly mirrors the rigorous modeling workflows enforced across major global aerospace design offices. Learners progress systematically from isolated reference points and continuous 3D splines to complex sweep operations, surface blends, and final solid shell transformations. This deep exposure to advanced styling environments provides young engineers with the design depth, model repair capabilities, and technical accuracy highly valued by aerospace development teams.

### Course Objectives

The objectives of this mini course are to:

I. Provide practical exposure to wireframe creation and surface generation architectures within the CATIA styling environment.
II. Enable students to construct complex, multi-curved aerospace external skin panels using parametric guide-curve networks.
III. Develop technical competency in managing boundary continuity levels (G0, G1, G2) across interconnected surface boundaries.
IV. Train participants to diagnose and repair data errors, gaps, and surface distortions in imported external CAD files.
V. Equip students with the specialized tools needed to transform complex hollow surface networks into manufacturable solid structures.

### Course Outcomes

Upon successful completion of this mini course, the student will be able to:

**CO 1**: Demonstrate proficiency navigating the Generative Shape Design (GSD) environment and organizing complex structural specification trees.

**CO 2**: Construct 3D wireframe skeletons utilizing advanced spatial points, curves, splines, and projection planes.

**CO 3**: Generate high-quality surface patches using multi-section profiles, advanced sweeps, and guide-curve controls.

**CO 4**: Analyze surface quality using visual curvature tools, checking boundary tangents and smooth highlight transitions.

**CO 5**: Execute surface cutting, adaptive trimming, and blend stitching operations to create closed skin envelopes.

**CO 6**: Convert verified external skin assemblies into feature-complete solid components ready for structural structural analysis.

**Course Content**

**Exercise 1**: Generative Shape Design Environment Configuration
Configuring specialized wireframe preferences, customizing local tool shelves, and establishing specification tree organization rules for complex surfacing paths.

**Exercise 2**: 3D Reference Wireframe Element Development
Generating point clouds, continuous coordinate planes, axes systems, and projection lines across multidimensional spaces.

**Exercise 3**: Advanced 3D Splines and Helical Curve Paths
Constructing smooth spatial curves, control points, curvature constraints, and helical tracks for complex geometry routing.

**Exercise 4**: Basic Surface Foundations: Extrude, Revolve, Sphere
Creating basic surface panels, setting extrusion limits, adjusting revolution boundaries, and creating spherical face sections.

**Exercise 5**: Offset and Project Surface Implementations
Developing constant and variable offset skins, projecting complex profiles onto curved faces, and analyzing surface deviations.

**Exercise 6**: Advanced Sweep Architectures with Guide Curves
Utilizing segment sweep tools, combining multiple explicit profiles, and utilizing guide lines to shape complex structural paths.

**Exercise 7**: Multi-Section Surface Generation
Constructing custom surface structures that transition across distinct geometric shapes using custom spine curves and guide boundaries.

**Exercise 8**: Boundary Continuity Control and Analysis
Applying G0 position check rules, G1 tangent alignment, and G2 curvature smoothing to surface intersections to ensure ideal quality.

**Exercise 9**: Surface Trim, Split, and Fillet Operations
Executing precise cutting actions on intersecting surface bodies, merging separate sheets, and shaping transition zones using variable radii surface fillets.

**Exercise 10**: Advanced Surface Blending and Join Methods
Designing clean bridge patches across disconnected surface boundaries, adjusting trim options, and combining separate surface clusters into single skins.

**Exercise 11**: Real-Time Curvature Analysis and Quality Inspection

Using zebra stripe mapping, porcupine curvature combs, and light reflection checks to isolate flat spots, surface dimples, or sharp profile twists.

**Exercise 12**: Outer Mold Line (OML) Wing Skin Construction
Building a detailed aircraft wing skin using custom airfoil coordinate profiles, leading-edge guide sweeps, and trailing-edge blend interfaces.

**Exercise 13**: Surface Healing and Defeature Repairs
Diagnosing imported model files, locating micro-gaps, cleaning up broken face boundaries, and rebuilding corrupted geometry zones.

**Exercise 14**: Thick Surface and Closed Volume Solid Conversions
Converting validated surface assemblies into physical solid models using thick-surface additions and closed-surface fills.

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|---|---|
| **Course Code** | **MIAEPD04** |
| **Course Name** | **Aerodynamic Flow Simulations using ANSYS CFX** |

## Course Overview

The course focuses on developing applied competencies in fluid dynamics modeling, finite volume discretization, and aerodynamic post-processing workflows essential for aerospace research and vehicle performance optimization. In today's digital development pipelines, verifying fluid interactions, aerodynamic drag forces, and thermal profiles via simulation toolsets is mandatory prior to physical wind tunnel manufacturing. This course bridges the gap between fluid mechanics equations and real-world design evaluation by training students to prepare fluid volumes, configure turbulence equations, and monitor solver convergence behaviors safely. It reflects the engineering simulation workflows adopted by aerospace research cells, defense defense labs, and propulsion consultancies, where numerical analysis forms the validation base for aerodynamic optimization and structural safety sign-offs.

## Professional Context and Industry Skill Demand

Aeronautical graduates are highly sought after for technical positions such as Aerodynamics Analyst, CFD Simulation Engineer, and Propulsion Systems Consultant. These roles require deep practical familiarity with mesh refinement strategies, physics setup choices, and engineering report generation to support design changes. This course layout mimics the exact processing steps used across modern commercial analysis offices. Learners transition from initial raw geometry cleaning and structured mesh generation to multi-equation solver adjustments, boundary definitions, and validation checks against empirical data. This structural methodology reinforces critical engineering judgment, helping young graduates excel in performance evaluation, thermal management, and flight efficiency design teams.

## Course Objectives

The objectives of this mini course are to:

I. Provide practical exposure to the end-to-end numerical simulation pipeline within the ANSYS CFX engineering workspace.
II. Enable students to extract, clean, and isolate complex 3D internal and external fluid volume enclosures from mechanical models.
III. Develop technical competency in generating high-quality meshes, establishing inflation layers, and evaluating grid cell orthogonality.
IV. Train participants to choose appropriate turbulence equations, boundary parameters, and solver targets matching physical flight speeds.
V. Equip students with the analytical skills to parse velocity contours, pressure distributions, lift/drag coefficients, and generate professional design validation files.

## Course Outcomes

Upon successful completion of this mini course, the student will be able to:

**CO 1**: Demonstrate proficiency in managing the ANSYS Workbench data tree, launching CFX sub-modules, and managing project files safely.

**CO 2**: Extract and simplify complex 3D fluid volume domains from raw CAD files, removing unnecessary geometric details.

**CO 3**: Generate high-quality computational grids with target inflation layers to capture boundary layer fluid physics accurately.

**CO 4**: Apply correct inlet, outlet, wall condition, and symmetry boundary parameters matching physical flight speeds.

**CO 5**: Configure multi-equation turbulence models and solver schemes while monitoring convergence stability plots.

**CO 6**: Produce comprehensive CFD technical reports combining quantitative lift/drag data with qualitative flow visualizations.

## Course Content

**Exercise 1**: ANSYS Workbench Project Flow and CFX Architecture
Navigating the integrated project window, linking geometric parts to mesh and solver modules, and understanding the core file structure of CFX.

**Exercise 2**: SpaceClaim Fluid Domain Extraction
Importing 3D part geometries, cleaning up small surface details, isolating external air spaces, and defining custom flow volumes.

**Exercise 3**: Computational Grid Generation and Element Control
Applying global element sizing rules, implementing local grid refinement patches, and managing cell structures across critical flow areas.

**Exercise 4**: Boundary Layer Inflation Layer Modeling
Configuring prismatic inflation layers along solid walls to resolve boundary velocity profiles, calculating first-cell heights.

**Exercise 5**: Mesh Quality Auditing and Metric Verification
Checking element skewness levels, monitoring orthogonal quality values, tracking aspect ratios, and optimizing the grid network.

**Exercise 6**: CFX-Pre Physics Environment Configuration
Setting fluid properties, adjusting reference pressure limits, choosing working fluids, and managing multi-component chemical properties.

**Exercise 7**: Boundary Condition Specifications for Flight
Applying velocity inlets, static pressure outlets, opening conditions, slip/no-slip wall properties, and symmetry planes to the domain.

**Exercise 8**: Turbulence Model Selection and Implementation
Selecting and deploying $k-\epsilon$, $k-\omega$, and Shear Stress Transport (SST) turbulence formulations based on local flow conditions.

**Exercise 9**: Solver Control Configuration and Convergence Target Setup
Adjusting advection schemes, selecting time-stepping loops, setting root-mean-square (RMS) residual targets, and initializing flow properties.

**Exercise 10**: CFX-Solver Manager and Convergence Monitoring
Tracking residual plot lines in real time, managing imbalances, and adjusting relaxation parameters to prevent simulation divergence.

**Exercise 11**: Flow Post-Processing: Vector and Contour Visualizations
Generating 2D plane slices, rendering colored pressure and velocity fields, and tracing fluid streamlines around structures.

**Exercise 12**: Aerodynamic Forces: Lift and Drag Calculation
Integrating surface pressure forces to calculate total lift and drag values, comparing results against classic analytical equations.

**Exercise 13**: High-Speed External Flow Over Airfoil Profiles
Simulating compressible subsonic airflow around an isolated airfoil, tracking separation points, and analyzing shockwave formations.

**Exercise 14**: Comprehensive Simulation Project and Technical Reporting
Executing an independent fluid analysis from geometry to solution, validating the results, and writing a structured engineering report.

## DEPARTMENT OF MECHANICAL ENGINEERING

The department of Mechanical Engineering is introducing Mini Courses for Continuous Improvement (MCCI) to empower students with industry-relevant skills, enhance employability, and prepare them to excel in modern design, analysis, advanced manufacturing, automation, robotics, and smart thermal energy domains.

The table shows list of Mini Courses offered in Mechanical Engineering department:

| S.No | Course Code | Course Name | Offered Semester |
|---|---|---|---|
| 1 | MIACMD01 | CAD Modelling and Product Design using SolidWorks | IV Semester |
| 2 | MIAEAD02 | Engineering Analysis using ANSYS | |
| 3 | MIACNP03 | CNC Programming and Manufacturing Simulation | VI Semester |
| 4 | MIAIAR04 | Industrial Automation and Robotics | |

**Graduates become competitive for opportunities in:**

- Manufacturing & Production Industries
- Automotive & Autonomous Vehicle Sector
- Aerospace & Defense Industries
- CAD/CAM/CAE Consultancies & Design Firms
- Industrial Automation & Robotics Companies
- Energy, Thermal, & HVAC Engineering Companies
- Design, Prototyping, & Product Development Organizations
- Government Departments & Mechanical Engineering Public Sector Units (PSUs)

| Course Code | MIACMD01 |
|---|---|

| Course Name | CAD Modelling and Product Design using SolidWorks |
|---|---|

**Course Overview**

The course focuses on developing hands-on skills in computer-aided design layout, parametric part modelling, assembly design, and professional drafting, which are essential for effective participation in real-world mechanical and manufacturing engineering projects. In today's manufacturing ecosystem, employers increasingly expect entry-level mechanical engineers to be capable of contributing from the conceptual engineering and pre-production planning stages of projects. This course bridges the gap between classroom learning and professional practice by training students to produce highly detailed, standard-compliant, and production-ready manufacturing models, enabling them to add value immediately upon entering the workforce.

It reflects the design workflows adopted by leading organizations such as Tata Motors, Larsen & Toubro, Mahindra & Mahindra, Godrej Aerospace, and similar national and global engineering enterprise companies, where accurate parametric visualization forms the foundation for digital manufacturing and structural integrity evaluation.

**Professional Context and Industry Skill Demand**

The CAD Modelling and Product Design using SolidWorks course is aligned with prevailing industry expectations in automotive, heavy machinery, aerospace, and product design sectors where proficiency in digital drafting and geometric dimensioning is essential. The course develops competencies in 3D part design, assembly configuration, interference check preparation, and structured product data creation, enabling effective contribution to real-time industrial production workflows. By reflecting professional practices followed in mechanical design and research development offices, it enhances readiness for roles in product design coordination, mechanical prototyping, and tool engineering. The emphasis on geometric validation, sheet metal layout, and bill of materials compliance strengthens technical reliability and documentation skills. This industry-oriented approach significantly improves graduate employability and workplace preparedness in mechanical engineering and product lifecycle management sectors.

Completion of this course enables participants to develop industry-aligned drafting competencies, strengthening their ability to contribute effectively to live assembly and component manufacturing workflows. The applied exposure gained through this course enhances professional readiness, technical confidence, and practical understanding of real-world design processes, supporting a smooth transition into structural, product validation, and plant engineering roles within the mechanical production sector.

**Course Objectives**

The objectives of this mini course are to:

- Provide practical exposure to industry-oriented parametric component design using modern CAD-based workflows.
- Enable students to analyze geometric constraints, tolerances, and design intents for effective component detailing.
- Develop competency in preparing assembly layouts and advanced configurations based on manufacturing constraints and mechanism motions.
- Train students to apply standard machine design rules and drafting conventions related to surface finish, weldments, and fits.

- Equip students with the ability to prepare professional, production-ready manufacturing sheets and bill of materials documentation used in mechanical design practice.

**Course Outcomes**

Upon successful completion of this mini course, the student will be able to:

- Demonstrate proficiency in setting up and customizing a professional CAD environment for standard mechanical component design.
- Evaluate mechanical drawings with respect to geometric constraints, dimensional intent, and manufacturing capability for effective design choices.
- Design and develop standard components and complex assembly units incorporating functional placement, kinematics, and tolerance requirements.
- Apply and verify drafting regulations, sheet metal patterns, and structural weldment standards to ensure compliance in product models.
- Interpret mechanical assembly sections, exploded views, complex surface intersections, and production manufacturing sheets.
- Develop complete engineering documentation including bill of materials, engineering design changes, and production-ready layout sheets in a professional format.

**Course Content**

**Exercise 1: CAD Environment Setup and Sketching Fundamentals:** Creation of a professional SolidWorks drawing template including custom units, standard document properties, line styles, coordinate parameters, and drafting metrics suitable for manufacturing drawings.

**Exercise 2: Parametric Intent and Geometric Relations:** Selection of sketch planes, application of fully defined geometric constraints, intent definition with north-axis or center reference, and understanding design constraints influencing mechanical modifications.

**Exercise 3: Part Modelling Using Extrusion and Revolved Features:** Preparation of 3D solid parts based on industrial input data and application of engineering design steps such as boss/base extrusion, cuts, holes, and revolves.

**Exercise 4: Advanced Part Features and Hole Wizard Application:** Conversion of basic solids into complex engine and housing components by applying standard fillets, draft angles, shells, and accurate multi-size threads using industrial standards.

**Exercise 5: Assembly Modelling and Standard Kinematic Mates:** Planning and placement of separate parts using standard concentric, coincident, and parallel mates, followed by kinematic motion validation as per mechanism requirements.

**Exercise 6: Interference Detection and Tolerance Analysis:** Preparation of assembled mechanism units to evaluate clearance fits, collision paths, structural overlap errors, and adjustment of clearances for functional operation.

**Exercise 7: Advanced Assembly Configurations and Exploded Views:** Modification of multi-part configurations based on variations in model size and creation of exploded assembly tracks to enhance production understanding.

**Exercise 8: Surface Modelling and Consumer Product Design:** Application of lofted, swept, and knitted surface operations for complex outer geometries, enabling aerodynamic contours and ergonomic product designs.

**Exercise 9: Sheet Metal Design and Unfolded Pattern Planning:** Application of base flanges, edge bends, and custom relief settings based on material thickness, along with generation of flat patterns for sheet fabrication.

**Exercise 10: Weldments and Structural Frame Design:** Design of structural machine frames and chassis using standard structural profiles, including corner treatments, end caps, and custom gussets as per welding parameters.

**Exercise 11: Production Drawing Setup and View Projections:** Creation and drafting of orthographic projections, isometric models, and exploded detail views from 3D models considering standard drawing layouts.

**Exercise 12: Sectional Views and Detailed Dimensioning:** Design of section cuts and detailed detail views to illustrate inner mechanisms, along with applying geometric dimensioning and tolerancing (GD&T) markers.

**Exercise 13: Bill of Materials (BOM) and Title Block Engineering:** Preparation of exact parts lists including item count, material specs, weight properties, and filling of professional title blocks for commercial release.

**Exercise 14: Final Product Development Project and Sheet Release:** Compilation of a complete production-ready documentation package including detail drawings, exploded layouts, design note spreadsheets, and assembly files.

| Course Code | MIAEAD02 |
|---|---|
| Course Name | Engineering Analysis using ANSYS |

**Course Overview**

The Engineering Analysis using ANSYS course focuses on developing applied competencies in numerical simulation, finite element modeling, and engineering validation that are essential for modern product engineering and stress assessment projects. In today's high-tech industrial ecosystem, organizations increasingly rely on simulation-based verification tools to evaluate mechanical component performance, optimize thermal dissipation, and validate structural structural safety before physical tool manufacturing. As a result, mechanical engineers are expected to possess practical exposure to Finite Element Analysis (FEA) platforms in addition to strong theoretical foundations in solid mechanics and thermodynamic equations.

The course bridges the gap between theoretical mechanical engineering calculations and real-world industrial practice by training learners to model and analyze structural members, thermal piping, rotating assemblies, high-cycle components, and multi-physics assemblies using industry-relevant CAE platforms. It reflects the simulation workflows adopted by engineering consultancies, automotive manufacturers, aerospace developers, and defense product testing agencies where simulation-driven analysis forms the foundation for safe, efficient, and lightweight component design.

**Professional Context and Skill Demand**

Mechanical Engineering graduates are increasingly recruited into technical roles such as FEA Simulation Analyst, Structural Validation Engineer, CAE Design Engineer, and Thermal Systems Support Specialist, where numerical evaluation forms a critical component of product optimization and safety verification. In these roles, professionals are expected to assist in mechanical modeling, structural optimization under dynamic loads, and validation of thermal gradients under varying structural conditions.

The course content mirrors established professional workflows followed in heavy structural engineering and automotive design offices. Learners begin with geometry preparation and mesh optimization, followed by application of boundary constraints, structural load definitions, solver selection, and systematic verification of numerical data. Emphasis is placed on mesh independence checks, convergence validation, and engineering judgment to ensure reliability of result datasets—an essential requirement in real-world aerospace validation and safety-critical failure prevention projects.

By integrating finite element computational tools with core design principles, the course strengthens analytical capability, structural diagnosis confidence, and engineering decision-making skills. This industry-aligned approach enhances readiness for roles in automotive frame design, aerospace structural analysis, turbo-machinery validation, thermal enclosure design, and safety compliance coordination, thereby significantly improving employability in the mechanical simulation and analysis domains.

**Course Objectives**

The objectives of course are to:

- Provide practical exposure to computational structural and thermal modeling using modern FEA tools.
- Enable learners to simulate structural stress, heat dissipation, and dynamic vibration signatures using numerical methods.
- Develop competency in engineering model cleanup, mesh generation, and application of realistic operational constraints.
- Equip participants with the ability to validate and document engineering simulation reports in a professional industrial format.

**Course Outcomes**

Upon successful completion of this mini course, the participant will be able to:

- Demonstrate proficiency in setting up FEA structural and thermal simulations using professional CAE software tools.
- Model and analyze mechanical stress distributions, heat transfers, and dynamic modes using finite element techniques.
- Apply appropriate structural boundary conditions, thermal contact behaviors, and numerical solver configurations for realistic mechanical analysis.
- Interpret CAE visualization outputs such as von Mises stress contours, thermal gradient patterns, safety factors, and displacement metrics.
- Validate simulation results by comparing them with classical mechanical principles, strength formulas, and empirical test benchmarks.
- Develop comprehensive engineering simulation reports that document mesh quality metrics, constraint logic, result interpretations, and optimization suggestions in accordance with industry practice standards.

**Course Content**

**Exercise 1: Introduction to FEA Workflow and ANSYS Workbench:** Understanding FEA fundamentals, governing equations, simulation workflows, and industrial applications in structural components, pressure vessels, thermal heatsinks, and rotating machinery.

**Exercise 2: Geometry Import, Cleanup, and Midsurface Extraction:** Import of 3D CAD files from external platforms into ANSYS SpaceClaim, deletion of redundant small features, and extraction of 2D midsurfaces for thin-walled industrial parts.

**Exercise 3: Mesh Generation and Quality Assessment Parameters:** Generation of global and localized structured/unstructured meshes, evaluation of mesh metrics (aspect ratio, jacobian, orthogonal quality), and refinement for accurate stress calculations.

**Exercise 4: Boundary Condition Application and Joint Definition:** Application of fixed, frictionless, and cylindrical supports based on operational setups, alongside setting up bonded and sliding contact conditions.

**Exercise 5: Static Structural Analysis of Beam and Truss Components:** Set up and analysis of simple structural frames under distributed loads, extracting reaction forces, bending moments, axial deflection, and validation with standard hand calculations.

**Exercise 6: Stress Concentration Evaluation in Notched Plates:** Modeling and simulation of plate models with geometric discontinuities, mesh refinement around holes, extraction of peak von Mises stresses, and checking stress concentration constants.

**Exercise 7: Mechanical Assembly Simulation and Contact Analysis:** FEA simulation of multi-part bolted joints and knuckle mechanisms, evaluation of contact pressure distribution, sliding behavior, and local load transfer characteristics.

**Exercise 8: Steady-State Thermal Analysis of Heat Dissipation Enclosures:** Simulation of thermal gradients across microelectronic fins and heatsinks, mapping temperature fields and heat flux paths under convective cooling factors.

**Exercise 9: Transient Thermal Modeling of Castings and Tooling:** Calculation of time-dependent temperature distributions during quenching and mold cooling operations, identifying thermal lag times and localized temperature differentials.

**Exercise 10: Structural Coupling of Thermal Stresses (Thermal-Structural FEA):** Import of transient thermal field datasets into static structural solvers to evaluate thermal contraction/expansion, localized thermal stress, and distortion tendencies.

**Exercise 11: Modal Analysis and Resonance Frequency Diagnostics:** Simulation of natural frequencies and mode shape contours for cantilevered components and machine brackets, identifying critical frequencies to prevent system resonance.

**Exercise 12: High-Cycle Fatigue and Operational Life Prediction:** Application of cyclic load variations using fatigue tool blocks to predict damage accumulation parameters, structural life limits, and factor of safety boundaries.

**Exercise 13: Topology Optimization for Weight Reduction Projects:** Application of volume and compliance optimization parameters to structural brackets, generating optimized material layouts that maintain mechanical integrity.

**Exercise 14: Major Engineering Validation Project and Report Generation:** End-to-end industrial FEA project execution comprising cad preparation, grid validation, solver selection, code verification, optimization steps, and generation of certification documents.

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| **Course Code** | **MIACNP03** |
| **Course Name** | **CNC Programming and Manufacturing Simulation** |

**Course Overview**

The CNC Programming and Manufacturing Simulation course focuses on developing applied competencies in computer-aided manufacturing (CAM), G-code logic compilation, toolpath generation, and machining environment simulation that are essential for modern manufacturing setups. In today's high-precision industrial ecosystem, organizations increasingly rely on digital manufacturing validations to guarantee production efficiency, prevent tool collisions, and optimize material removal rates before actual setup implementation. As a result, production engineers are expected to possess deep expertise in CAM software and machine code orchestration alongside standard knowledge of material science and machining variables.

The course bridges the gap between manual workshop practices and high-end industrial automation by training students to program, simulate, and optimize turning and milling operations on multi-axis machines using advanced CAM interfaces. It reflects the advanced manufacturing methodologies adopted by market leaders like Bharat Forge, Godrej Precision Engineering, HAL, and leading automotive machining vendors where error-free simulation forms the prerequisite for high-speed machining and cost-effective batch production.

**Professional Context and Skill Demand**

Mechanical Engineering graduates are highly sought after for corporate tracks like CAM Programming Engineer, CNC Production Supervisor, Production Planning Analyst, and Tooling Design Engineer within machine tool factories and precision components plants. In these specialized functions, professionals must build error-free code scripts, calculate precise feeds/speeds, define component setups, and evaluate complete machining architectures under multi-axis conditions.

The curriculum directly translates into professional sequences utilized in advanced machine shops. Learners configure component reference coordinate systems, map out roughing and finishing paths, deploy standard cutter compensation rules, and check code using material removal verification tools. Emphasis is placed on cycles optimization, collision tracking, and surface finish estimations—vital skillsets in high-value automotive molds and aerospace part production.

By synthesizing core manufacturing operations with digital simulation setups, this module enhances geometric translation capabilities, process planning precision, and data analysis routines. This specialized orientation improves preparation for leadership in modern CNC machining cells, mold manufacturing lines, automated parts setup units, and rapid tooling houses, boosting employment potential in modern production markets.

**Course Objectives**

The objectives of this mini course are to:

- Provide practical exposure to digital toolpath generation and G/M code structures using modern CAM applications.
- Enable learners to program and coordinate multi-axis turning and milling tracks based on engineering print requirements.
- Develop competency in setup definition, cutter select routines, and optimization of cutting variables.
- Equip participants with the ability to simulate, troubleshoot, and export verified machine post-processor files for commercial hardware engines.

**Course Outcomes**

Upon successful completion of this mini course, the participant will be able to:

- Demonstrate proficiency in setting up digital CAM environments for comprehensive manufacturing simulations.
- Model and generate production-ready code blocks for intricate lathe and mill geometries.
- Apply appropriate machining sequences, tool geometry selections, and feed rates for optimized manufacturing processing.
- Interpret and troubleshoot G-code and M-code listings to correct structural path errors and code syntax deviations.
- Validate volumetric material removal, execution cycles, and tool wear indications using digital machine verification suites.
- Develop comprehensive process plan reports compiling part fixtures, structural tool catalogs, cutting variables, and post-processed NC files according to industrial validation norms.

**Course Content**

**Exercise 1: CNC Architecture and Foundation of NC Syntax:** Analysis of CNC mechanical design layout, absolute and incremental programming logic, structure of word address blocks, and overview of basic G/M functions for turning/milling.

**Exercise 2: Manual Programming for Contour Turning Operations:** Calculation of profile coordinate matrices, manual drafting of NC scripts using linear/circular interpolation codes, and testing on standalone simulation screens.

**Exercise 3: Manual Programming for Lathe Threading and Grooving Canned Cycles:** Application of multi-pass stock removal turning loops and threading sequences to reduce script line count and maximize production efficiency.

**Exercise 4: Manual Programming for 2D Mill Contouring and Pocketing:** Defining part zeros, programming linear ramp entries, inner slot profiles, and square pocket steps while maintaining tool radius compensation adjustments.

**Exercise 5: Manual Programming for Drilling and Boring Canned Cycles:** Applying standard drilling loops, deep-hole peck drilling sequences, and high-precision boring tracks on symmetric block layouts.

**Exercise 6: CAM Environment Interface and Geometry Import:** Orientation with MasterCAM/Siemens NX manufacturing templates, importing external solid files, and defining stock dimensions and clamp geometries.

**Exercise 7: Digital Toolpath Generation for Face Milling and Roughing:** Generating parallel and dynamic opti-rough toolpaths, determining depth steps, setting step-over percentages, and calculating material removal metrics.

**Exercise 8: 2D High-Speed Core and Cavity Pocket Milling Simulation:** Setting up high-speed trocho-machining paths inside closed die cavities, checking helix approach paths, and verifying tool engagement factors.

**Exercise 9: 3D Surface Finish Machining and Toolpath Refinement:** Implementing scallop, raster, and constant-Z finishing sequences on contoured models to generate high-quality surface integrity parameters.

**Exercise 10: Digital Lathe Profiling and Automatic Toolpath Generation:** Setting up internal boring, outer profiling, and parting cuts via CAM software wizard blocks, matching tool turret assignments.

**Exercise 11: Machine Simulation, Collision Check, and Gouge Verification:** Execution of complete virtual machine kinematics, tracking collisions between toolholders and fixtures, and checking for part gouges.

**Exercise 12: Cycle Time Calculation and Feed Rate Optimization:** Profiling acceleration/deceleration steps, adjusting feed schedules relative to chip loads, and refining cycles to reduce production time.

**Exercise 13: Post-Processing and NC Code Generation for Specific Controllers:** Converting internal CAM toolpaths into specific NC codes formatted for Fanuc, Siemens, and Haas machine control units.

**Exercise 14: Integrated Manufacturing Case Study and G-Code Verification:** Full production run deployment including detailed process planning, tool library definition, full CAM simulation, post-processor delivery, and delivery of production sheets.

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|---|---|
| **Course Code** | **MIACNP03** |
| **Course Name** | **Industrial Automation and Robotics** |

**Course Overview**
The Industrial Automation and Robotics course focuses on developing applied competencies in programmable logic controllers (PLCs), electro-pneumatic process design, robot kinematics programming, and smart automation system integration which are essential for contemporary manufacturing industries. In the current manufacturing paradigm, industries are rapidly converting conventional assembly floors into intelligent automated lines driven by real-time sensor loops and robotic workcells. Consequently, contemporary mechanical engineers must cultivate strong multi-disciplinary automation capabilities alongside traditional plant layouts to design and optimize advanced production systems.

This course acts as a link between classical mechanical systems and smart manufacturing configurations by instructing students in configuring sensor loops, constructing pneumatic actuators, programming articulated industrial robots, and managing automated assembly flows. It duplicates the advanced manufacturing workflows utilized by sector pioneers such as Siemens, Bosch Rexroth, Fanuc, ABB Robotics, and Maruti Suzuki where integrated automation structures form the core of smart factory operations and high-volume mass customization.

**Professional Context and Skill Demand**
Graduates from Mechanical Engineering departments are continuously placed into key industrial roles such as Automation Engineer, Robotics Programmer, Mechatronics Systems Analyst, and Smart Factory Line Integrator within automotive assembly plants, automated packaging houses, and e-commerce distribution facilities. In these roles, professionals must build robust control logic, integrate field sensors, design safe pneumatic layouts, and manage coordinated trajectories for multi-axis handling equipment.

The curriculum maps out the standard operational phases followed by system integration engineering firms. Students start by establishing field I/O connections, writing ladder logic routines, planning pneumatic flow circuits with emergency reliefs, and modeling physical workcells within complete multi-tool environments. Special attention is dedicated to safety interlocking layouts, industrial communication stability, and cycle synchronization—critical steps in modern industrial product sorters and continuous automotive welding cells.

By joining mechanical hardware with digital control logic, the course improves cross-functional system engineering capabilities, logical troubleshooting processes, and advanced industrial control configurations. This multi-disciplinary approach ensures strong preparation for career tracks in factory floor integration, robotic assembly design, flexible manufacturing cell deployment, and Industry 4.0 system upgrades, maximizing corporate value in the modern engineering landscape.

**Course Objectives**

The objectives of this mini course are to:

- Provide practical exposure to industrial PLC programming and real-time field sensor integration.
- Enable learners to design, simulate, and analyze electro-pneumatic actuation circuits for sequential production cycles.

- Develop competency in coordinate frame definitions, offline robot programming, and trajectory generation.
- Equip participants with the ability to design and validate synchronized automated manufacturing cells using modern simulation platforms.

**Course Outcomes**

Upon successful completion of this mini course, the participant will be able to:

- Demonstrate proficiency in setting up hardware interfaces, PLC configurations, and industrial communication parameters.
- Model and deploy structured ladder logic codes for continuous process regulation and machine automation.
- Design and execute functional electro-pneumatic circuits matching specific sequential industrial cycle requirements.
- Interpret and compose industrial robot programs for material handling, picking, and path tracking.
- Validate workcell layouts, safety interlocking loops, and cycle coordination parameters using digital simulation environments.
- Develop comprehensive automation project documentation comprising electrical layouts, pneumatic flow charts, PLC code prints, and robot path catalogs aligned with industry practice standards.

**Course Content**

**Exercise 1: Introduction to Automation Pyramid and Field Sensor Integration:** Study of industrial control hierarchies, hardware interfaces, and wiring up inductive, capacitive, photoelectric, and ultrasonic sensors to control loops.

**Exercise 2: PLC Hardware Configuration and I/O Addressing Logic:** Setting up PLC rack modules, configuring central processors, allocating digital/analog I/O address domains, and managing electrical panel connections.

**Exercise 3: Basic PLC Programming – Implementing Core Logic and Interlocks:** Development of ladder logic scripts utilizing standard contacts, coils, latching functions, and electrical safety interlocks for machine start/stop cycles[cite: 4, 5].

**Exercise 4: Industrial Motor Control Architecture Using PLC:** Programming Direct-On-Line (DOL) star-delta sequences in ladder logic, including forward-reverse steps and overload relay monitoring.

**Exercise 5: Advanced PLC Functions – Timers and Counters Applications:** Designing automated material handling sequences by integrating on-delay/off-delay timers and counter blocks to regulate part spacing.

**Exercise 6: Analog Data Scaling and Process Regulation:** Interfacing industrial RTD temperature elements or pressure transducers with PLC analog input modules, scaling data, and configuring basic control loops.

**Exercise 7: Industrial Communication Protocols and HMI Design:** Establishing Modbus/Profinet data links between PLC controllers and HMI stations, creating tags, and designing graphical control buttons.

**Exercise 8: Pneumatic Foundation and Directional Valve Configurations:** Selection of filters, regulators, and lubricators (FRL units), along with configuring manual, mechanical, and pilot-operated directional control valves.

**Exercise 9: Design of Sequential Multi-Actuator Pneumatic Circuits:** Constructing pneumatic circuits for multi-cylinder tasks using cascade methods, validating travel-step diagrams for production sorting.

**Exercise 10: Electro-Pneumatic Control and Solenoid Interfacing:** Interfacing electrical control relays and 24V DC solenoid valves with pneumatic cylinders, realizing automatic return cycles via limit switch inputs.

**Exercise 11: Industrial Robotics Architecture and Coordinate Systems:** Configuration of 6-DOF articulated arm mechanisms, mastering Joint, World, and Tool Coordinate Systems (TCS), and defining Tool Center Points (TCP).

**Exercise 12: Robot Jogging and Motion Command Programming:** Teaching spatial path waypoints using teach pendants, programming joint (MOVEJ), linear (MOVEL), and circular (MOVEC) trajectories for sorting loops.

**Exercise 13: Offline Robot Programming and Virtual Workcell Layout Design:** Modeling complete pick-and-place workcells within RoboDK, positioning conveyors, defining part feeders, and creating collision-free motion scripts.

**Exercise 14: Integrated Industry 4.0 Manufacturing Cell Project:** Full design of a factory cell combining PLC logic, electro-pneumatic pickers, and synchronized robotic arms, concluding with a comprehensive engineering report.

# DEPARTMENT OF CIVIL ENGINEERING

The department of Civil Engineering is introducing **Mini Courses for Continuous Improvement (MICC)** to empower students with industry-relevant skills, enhance employability, and prepare them to excel in modern construction, infrastructure, environmental, transportation, and sustainability domains.

The table shows list of Mini Courses offered in Civil Engineering department

| S.No | Course Code | Course Name | Offered Semester |
|---|---|---|---|
| 1 | MIABPD01 | Applied Building Planning | IV Semester |
| 2 | MIACFD02 | Computational Hydraulics Using CFD | |
| 3 | MIASDD03 | Survey Drafting & Mapping | VI Semester |
| 4 | MIASAD04 | Steel Structure Modelling, Analysis and Drawing | |

**Graduates become competitive for opportunities in:**

- Construction & Infrastructure Development Companies
- Urban Planning & Smart City Missions
- BIM & Digital Construction Consultancies
- Water Resources, Irrigation, and Transportation Planning
- Sustainability, Green Building, and Climate Analytics Organizations
- Government Departments & Civil Engineering Public Sector Units (PSUs)

## COURSE DETAILS

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|---|---|
| **Course Code** | **MIABPD01** |
| **Course Name** | **Applied Building Planning** |

**Course Overview**

The course focuses on developing hands-on skills in building layout planning, CAD-based drafting, and regulatory compliance, which are essential for effective participation in real-world construction and infrastructure projects.In today’s construction ecosystem, employers increasingly expect entry-level civil engineers to be capable of contributing from the pre-execution and planning stages of projects. This course bridges the gap between classroom learning and professional practice by training students to produce functional, regulation-compliant, and presentation-ready building plans, enabling them to add value immediately upon entering the workforce.

It reflects the planning workflows adopted by leading organizations such **as Larsen & Toubro, Tata Projects, NCC Limited**, and similar national and global infrastructure companies, where accurate planning documentation forms the foundation for design coordination and project execution.

**Professional Context and Industry Skill Demand**

The Applied Building Planning course is aligned with prevailing industry expectations in construction, infrastructure, and consultancy sectors where proficiency in CAD drafting and regulatory compliance is essential. The course develops competencies in building layout preparation, approval drawings, and structured planning documentation, enabling effective contribution to real-time project workflows. By reflecting professional practices followed in planning and design offices, it enhances readiness for roles in planning, design coordination, and site execution. The emphasis on functional zoning, circulation planning, and bye-law compliance strengthens technical reliability and documentation skills. This industry-oriented approach significantly improves graduate employability and workplace preparedness in building and infrastructure projects.

Completion of this course enables participants to develop industry-aligned planning competencies, strengthening their ability to contribute effectively to live construction projects. The applied exposure gained through this course enhances professional readiness, technical confidence, and practical understanding of real-world planning processes, supporting a smooth transition into planning, design, and execution roles within the construction and infrastructure sector.

**Course Objectives**
**The objectives of this mini course are to:**

I. Provide practical exposure to industry-oriented residential building planning using CAD-based workflows.
II. Enable students to analyze plot characteristics, orientation, and site feasibility for effective residential planning.
III. Develop competency in preparing conceptual and detailed residential building layouts based on functional zoning and planning principles.
IV. Train students to apply building bye-laws and planning standards related to ventilation, circulation, setbacks, and parking.
V. Equip students with the ability to prepare professional, submission-ready drawings and planning documentation used in civil and architectural practice.

**Course Outcomes**

**Upon successful completion of this mini course, the student will be able to:**

1. Demonstrate proficiency in setting up and using a professional CAD environment for residential building planning drawings.

2. Evaluate residential plots with respect to orientation, access, and site constraints for effective planning decisions.
3. Design and develop concept and detailed residential plans incorporating functional zoning, circulation, and usability requirements.
4. Apply and verify planning regulations and building bye-laws to ensure compliance in residential layouts.
5. Interpret elevations, sections, staircases, and site layouts for residential buildings.
6. Develop complete planning documentation including planning notes, area schedules, and submission-ready drawing sets in a professional format.

**Course Content:**

**Exercise 1: CAD Environment Setup for Building Planning**
Creation of a professional AutoCAD drawing template including units, layers, text styles, dimension styles, and drafting standards suitable for residential building planning drawings.

**Exercise 2: Plot Selection, Orientation and Site Feasibility**
Selection of residential plot size, analysis of orientation with respect to north direction, preparation of basic site plan, and understanding site constraints influencing planning decisions.

**Exercise 3: Concept Residential Planning Using Line Plan and Zoning**
Preparation of concept line plan based on room requirements and application of functional zoning principles such as public, semi-private, and private spaces.

**Exercise 4: Wall Plan Development and Room Identification**
Conversion of line plan into wall plan by applying appropriate wall thicknesses and systematic room identification using standard architectural naming conventions.

**Exercise 5: Door, Window and Ventilation Planning**
Planning and placement of doors and windows using standard sizes and symbols, followed by verification of ventilation requirements as per applicable building bye-laws.

**Exercise 6: Furniture Layout and Circulation Analysis**
Preparation of furnished residential plans to study circulation paths, movement efficiency, ergonomic clearances, and optimization of furniture layout for usability.

**Exercise 7: Climate Responsive Planning and Cross Ventilation**
Modification of residential layouts based on daylight orientation and improvement of cross ventilation to enhance indoor comfort and energy efficiency.

**Exercise 8: Material Representation, Annotation and Dimensioning**
Application of hatch patterns for floors and walls, professional annotation practices, and accurate dimensioning to prepare construction-ready drawings.

**Exercise 9: Setback Application and Plot Boundary Planning**
Application of front, side, and rear setbacks based on plot size and bye-laws, along with drawing of plot boundaries and compound wall layout.

**Exercise 10: Site Access and Parking Layout Planning**
Planning of approach road, site access points, and parking layout as per residential standards, ensuring safe and efficient vehicular movement.

**Exercise 11: Residential Unit Planning – 1BHK, 2BHK and 3BHK**
Planning and drafting of different residential unit types including 1BHK, 2BHK, and 3BHK

layouts, considering functional requirements and regulatory compliance.

**Exercise 12: Vertical Planning – Staircase, Elevation and Section**
Planning of staircase dimensions, preparation of building elevation, and sectional view to understand vertical relationships and building proportions.

**Exercise 13: Planning Notes, Area Schedule and Compliance Check**
Preparation of planning notes as per bye-laws, verification of minimum room sizes, and preparation of area schedule and room data sheets.

**Exercise 14: Final Submission Drawings and Documentation**
Compilation of complete submission-ready drawing set including plans, elevations, sections, title block, legend, and presentation sheets.

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|---|---|
| **Course Code** | **MIABPD02** |
| **Course Name** | **Computational Hydraulics Using CFD** |

**Overview**

The Computational Hydraulics Using CFD course focuses on developing applied competencies in numerical simulation, hydraulic modeling, and computational analysis that are essential for modern water resources and infrastructure projects. In today's engineering ecosystem, organizations increasingly rely on simulation-based tools to evaluate fluid flow behavior, optimize hydraulic performance, and validate designs before project execution. As a result, civil engineers are expected to possess practical exposure to Computational Fluid Dynamics (CFD) tools in addition to strong theoretical foundations in fluid mechanics.

The course bridges the gap between theoretical hydraulic concepts and real-world engineering practice by training learners to model and analyze pipe flow, open channel flow, spillways, culverts, and other hydraulic systems using industry-relevant CFD platforms. It reflects the computational workflows adopted by engineering consultancies, infrastructure developers, research organizations, and water resource agencies where simulation-driven analysis forms the foundation for safe, efficient, and sustainable hydraulic system design.

**Professional Context and Skill Demand**

Civil Engineering graduates are increasingly recruited into technical roles such as Hydraulic Design Engineer, Water Resources Analyst, Simulation Engineer, and Environmental Engineering Support Engineer, where computational analysis forms a critical component of project planning and design validation. In these roles, professionals are expected to assist in hydraulic modeling, performance assessment of water conveyance systems, and evaluation of flow characteristics under varying boundary conditions.

The course content mirrors established professional workflows followed in hydraulic design offices and infrastructure consultancy firms. Learners begin with geometry development and mesh generation, followed by application of boundary conditions, turbulence modeling, solver configuration, and systematic interpretation of simulation results. Emphasis is placed on validation, convergence assessment, and engineering judgment to ensure reliability of results—an essential requirement in real-world hydraulic design and flood management projects.

By integrating computational tools with core hydraulic principles, the course strengthens analytical capability, technical confidence, and decision-making skills. This industry-aligned approach enhances readiness for roles in water resources engineering, irrigation projects, flood mitigation systems, environmental flow analysis, and infrastructure planning, thereby significantly improving employability in hydraulic and environmental engineering domains.

**Course Objectives**

**The objectives of course are to:**

I. Provide practical exposure to computational modeling of hydraulic systems using CFD tools.
II. Enable learners to simulate pipe flow, open channel flow, and hydraulic structures using numerical methods.
III. Develop competency in geometry creation, mesh generation, and application of appropriate boundary conditions.
IV. Equip participants with the ability to validate and document CFD simulation results in a professional engineering format.

**Course Outcomes**

**Upon successful completion of this mini course, the participant will be able to:**

1. Demonstrate proficiency in setting up CFD simulations for hydraulic systems using professional software tools.
2. Model and analyze pipe flow, open channel flow, and basic hydraulic structures using numerical techniques.
3. Apply appropriate boundary conditions, turbulence models, and solver settings for realistic hydraulic simulations.
4. Interpret CFD outputs such as velocity contours, pressure fields, streamlines, and flow profiles for engineering evaluation.
5. Validate simulation results by comparing them with theoretical hydraulic principles and empirical relationships.
6. Develop comprehensive CFD simulation reports that document modeling methodology, validation procedures, result interpretation, and engineering conclusions in accordance with professional practice standards.

**Course Content:**

**Exercise 1: Introduction to CFD Workflow for Hydraulic Applications**
Understanding CFD fundamentals, governing equations, CFD workflow, and applications in hydraulic engineering including channels, pipes, spillways, and river systems.

**Exercise 2: Geometry Creation for Hydraulic Domains**
Development of 2D and 3D geometries for open channels and pipe systems, identification of inlet, outlet, wall, and symmetry boundaries, and preparation of simulation-ready hydraulic domains.

**Exercise 3: Mesh Generation and Quality Assessment**
Generation of structured and unstructured meshes, assessment of mesh quality parameters (skewness, orthogonality, aspect ratio), and refinement strategies for accurate hydraulic simulations.

**Exercise 4: Boundary Condition Definition for Hydraulic Flows**
Application of appropriate inlet, outlet, wall roughness, free-surface, and symmetry boundary conditions based on hydraulic physics and flow requirements.

**Exercise 5: Turbulence Modelling for Hydraulic Systems**
Study and application of turbulence models such as k–ε, k–ω, SST, and LES for open channel flow, pipe flow, hydraulic jumps, and high-Reynolds-number flows.

**Exercise 6: Solver Setup, Convergence, and Validation**
Configuration of solver schemes, pressure–velocity coupling, discretization methods, convergence monitoring, and validation of CFD results using engineering judgment.

**Exercise 7: CFD Simulation of Pipe Flow**
Simulation and analysis of laminar and turbulent pipe flow, extraction of velocity profiles, pressure drop, friction factor, and comparison with analytical solutions and Moody chart.

**Exercise 8: Open Channel Velocity Distribution and Uniform Flow Analysis**
Simulation of velocity variation across depth and width in open channels, extraction of velocity profiles, and comparison with theoretical logarithmic or power-law distributions.

**Exercise 9: Validation of Open Channel Flow Equations Using CFD**
CFD-based verification of Manning's and Chezy's equations, including comparison of discharge, velocity, hydraulic radius, and resistance effects.

**Exercise 10: Specific Energy, Critical Depth, and GVF Analysis**
Derivation of specific energy curves, identification of critical depth, computation of Froude number, and simulation of gradually varied flow profiles (M1, M2, S1, etc.).

**Exercise 11: Simulation of Rapidly Varied Flow**
CFD modelling of hydraulic jump characteristics including sequent depths, energy loss, turbulence structure, and jump classification using free-surface models.

**Exercise 12: CFD Analysis of Hydraulic Structures**
Simulation of flow over weirs, spillways, sluice gates, culverts, and stilling basins; analysis of nappe formation, pressure distribution, cavitation risk, and energy dissipation.

**Exercise 13: River and Urban Flow Applications Using CFD**
CFD analysis of flow around piers, compound channels, flood routing, sediment transport, and urban drainage systems to understand real-world hydraulic challenges.

**Exercise 14: Major CFD Case Study and Project**

End-to-end CFD project involving geometry creation, meshing, solver setup, steady/transient simulation, validation, interpretation, and professional report preparation for a selected hydraulic system.

| **Course Code** | **MIABPD03** |
|---|---|
| **Course Name** | **Steel Structure Modelling, Analysis and Drawing** |

## Overview

The Steel Structure Modelling, Analysis and Drawing course focuses on developing applied competencies in structural modeling, load analysis, and professional detailing of steel structures used in industrial, commercial, and infrastructure projects. In today's construction and infrastructure sector, engineering organizations increasingly expect civil engineers to possess practical exposure to structural analysis software and detailing workflows that support safe, code-compliant, and execution-ready designs.

The course bridges theoretical structural engineering concepts with real-world professional practice by training learners to model steel beams, columns, trusses, industrial sheds, and multi-storey frames; apply loads as per relevant design codes; and interpret structural responses for decision-making. It reflects the workflows adopted by leading organizations such as **Larsen & Toubro (Heavy Engineering & Construction Division), Tata Projects, NCC Limited, Afcons Infrastructure Megha Engineering & Infrastructures Limited (MEIL), JSW Engineering, ASBL**, where structural modeling, analysis validation, and detailing form the foundation for project execution.

## Professional Context and Skill Demand

Civil Engineering graduates are recruited into roles such as Structural Design Engineer, Junior Structural Analyst, CAD Detailer, and Design Support Engineer in structural consultancy firms, EPC contractors, and infrastructure development organizations. In these roles, professionals are expected to assist in structural modeling, load application, analysis interpretation, and preparation of fabrication-ready drawings for steel structures.

The course content mirrors professional workflows followed in structural design offices. Learners begin with section selection and modeling of structural components, followed by application of dead, live, wind, and seismic loads in accordance with relevant IS codes. Emphasis is placed on interpretation of structural behavior, identification of critical members, and preparation of general arrangement drawings and detailing sheets suitable for technical review and execution.

By integrating structural analysis tools with codal provisions and detailing standards, the course enhances analytical capability, design interpretation skills, and professional documentation competence. This industry-aligned approach strengthens readiness for roles in structural design, project coordination, fabrication detailing, and infrastructure execution, thereby significantly improving employability in the structural engineering domain.

**Course Objectives**

**The objectives of this mini course are to:**

I. Introduce students to structural modelling concepts for steel structures.
II. Enable application of loads and boundary conditions as per relevant design standards.
III. Develop skills in interpreting structural analysis results.
IV. Train students in preparation of steel structural drawings and documentation.
V. Build industry-ready competency in steel structure design workflows.

**Course Outcomes**

Upon successful completion of this mini course, the participant will be able to:

1. Develop structural models of steel beams, columns, trusses, and frames using professional analysis software.
2. Apply appropriate load combinations and boundary conditions in accordance with relevant design codes.
3. Analyze and interpret structural responses including internal forces, reactions, and deflections.
4. Evaluate structural behavior to identify critical members and assess performance under applied loading.
5. Create drawings and detailing sheets for steel components in accordance with relevant design codes.
6. Develop structured structural analysis reports for professional evaluation.

**Course Content:**

**Exercise 1: Introduction to Steel Sections and Codal Designation**
Identification of commonly used structural steel sections and understanding of codal nomenclature as per IS standards for beams, columns, trusses, and frames.

**Exercise 2: Drafting of Standard Steel Section Profiles**
Drafting of I-sections, channel sections, angle sections, and T-sections with correct dimensions, proportions, annotations, and drafting standards.

**Exercise 3: Structural Modelling of Steel Beam and Column Elements**
Modelling of individual steel beam and column elements with proper section properties, supports, and boundary conditions using structural modelling tools.

**Exercise 4: Drafting of Beam–Column Layout for Steel Buildings**
Preparation of beam–column grid layout plans showing structural framing arrangement,

alignment, member labeling, and coordination.

**Exercise 5: Modelling of Simple Steel Portal Frame**
Creation of a basic steel portal frame model including columns, rafters, and connections, representing typical industrial and warehouse structures.

**Exercise 6: Structural Analysis of Steel Members under Gravity Loads**
Analysis of steel beams and columns subjected to dead load and live load, including interpretation of shear force, bending moment, axial force, and deflection results.

**Exercise 7: Modelling and Analysis of Steel Roof Truss**
Modelling of steel roof truss geometry and analysis under dead and live loads to study axial force distribution and truss behaviour.

**Exercise 8: Drafting of Steel Truss Members and Connection Details**
Preparation of detailed drawings for steel truss members and their bolted or welded connections following standard detailing practices.

**Exercise 9: Modelling and Analysis of Steel Frame under Lateral Loads**
Analysis of steel frames subjected to wind or equivalent lateral loads to understand displacement behaviour, internal forces, and stability.

**Exercise 10: Modelling of Industrial Steel Shed Structure**
Modelling of a complete industrial steel shed including columns, rafters, purlins, and bracing systems representing real industrial applications.

**Exercise 11: Load Calculation and Application as per IS Codes**
Calculation of dead, live, wind, and other relevant loads as per IS codes and application of load combinations in steel structural models.

**Exercise 12: Modelling and Analysis of Multi-storey Steel Frame**
Modelling and analysis of a multi-storey steel frame subjected to gravity loads, including interpretation of axial forces, moments, and storey behaviour.

**Exercise 13: Preparation of Steel Structural Drawings and BOQ**
Preparation of general arrangement drawings, member layouts, fabrication-ready drawings, and bill of quantities for steel structures.

**Exercise 14: Integrated Steel Structure Case Study**
Complete case study involving modelling, analysis, detailing, and documentation of a steel structure, integrating all concepts learned in the course.

| Course Code | MIABPD04 |
|---|---|
| Course Name | Survey Drafting & Mapping |

**Overview**

The Survey Drafting & Mapping course focuses on developing applied competencies in survey data processing, digital drafting, and professional map preparation that are essential for land development, infrastructure planning, and construction projects. In today's engineering environment, civil engineers are expected to convert field survey measurements into accurate, scale-compliant digital drawings using CAD-based workflows.

The course bridges field surveying practices with professional drafting standards by training learners to prepare plan drawings, contour maps, boundary layouts, and topographical representations used in highways, buildings, irrigation systems, and urban development projects. It reflects drafting and mapping workflows adopted by engineering consultancies, infrastructure developers, and government planning agencies, where accurate survey documentation forms the foundation for design, estimation, and execution.

**Professional Context and Skill Demand**

Civil Engineering graduates are recruited into roles such as Site Engineer, Survey Engineer, Planning Assistant, CAD Technician, and GIS Support Engineer, where preparation and interpretation of survey drawings form an integral part of daily professional responsibilities. Organizations including engineering consultancies, infrastructure companies, and government departments rely on precise survey-based drawings for alignment planning, land subdivision, contour analysis, and project execution.

The course content mirrors professional survey drafting workflows followed in design and planning offices. Learners begin with coordinate plotting, traverse mapping, and boundary preparation, followed by contour generation, area calculation, annotation, and preparation of submission-ready map sheets. Emphasis is placed on accuracy, scale consistency, standard symbols, legends, and documentation practices to ensure reliability in planning and design decision-making.

**Course Objectives**
**The objectives of this mini course are to:**

I. Develop competency in drafting survey drawings using CAD tools.
II. Enable students to convert field survey data into accurate plan drawings.
III. Train students in preparation of contour maps and topographical plans.
IV. Enhance understanding of scales, symbols, and annotations used in survey maps.
V. Prepare students for professional roles involving surveying documentation and mapping tasks.

**Course Outcomes**
**Upon successful completion of this mini course, the participant will be able to:**

1. Prepare professional survey drawings and maps using standard CAD drafting practices.
2. Apply appropriate plotting techniques to construct traverse layouts, spot levels, and contour lines with scale accuracy.
3. Interpret and analyze topographical maps and survey layouts for planning applications.
4. Apply appropriate scales, symbols, legends, and annotations in survey documentation.
5. Develop boundary layouts and area calculations suitable for planning and execution purposes.
6. Develop structured survey documentation, including drawings and calculations, suitable

for professional review.

**Course Content:**

**Exercise 1: CAD Environment Setup for Survey Drafting**
Setting drawing units, precision, coordinate system, and basic drafting environment in AutoCAD suitable for survey and mapping applications.

**Exercise 2: Creation of Survey Layers, Line Types, and Symbols**
Preparation of survey-specific layers, line types, and standard survey symbols such as trees, poles, benchmarks, and utilities following drafting standards.

**Exercise 3: Plotting Survey Points Using Coordinate Methods**
Plotting survey points using absolute, relative, and polar coordinates and organizing point data for accurate spatial representation.

**Exercise 4: Annotation and Verification of Survey Points**
Labeling station points with text, checking plotted distances against field data, and validating point accuracy.

**Exercise 5: Plotting and Checking Closed Traverse**
Plotting closed traverse from given coordinates, checking angular and linear closure, and applying corrections where necessary.

**Exercise 6: Plotting Open Traverse for Route Surveys**
Plotting open traverse for linear features such as roads, canals, or pipelines with proper scale, orientation, and annotations.

**Exercise 7: Property Boundary Plotting and Area Calculation**
Drawing property boundary lines, marking boundary dimensions, and calculating plot area using AutoCAD tools.

**Exercise 8: Preparation of Boundary Map Sheet**
Adding north direction, scale, legend, and preparing a clean, submission-ready boundary map sheet.

**Exercise 9: Plotting Spot Levels and Reduced Levels (RLs)**
Plotting spot levels from RL data and preparing base drawings for contour and terrain analysis.

**Exercise 10: Contour Generation and Terrain Interpretation**
Interpolation of contour points, drawing contour lines at given intervals, and labeling contours accurately.

**Exercise 11: Slope, Ridge, and Valley Identification**
Identification of ridge lines, valley lines, and slope directions from contour maps for terrain interpretation.

**Exercise 12: Preparation of Contour Map Sheet**
Compilation of spot levels, contours, slope directions, legends, north arrow, and scale into a complete contour map sheet.

**Exercise 13: Site Layout Planning Using Survey Data**
Preparation of site boundary with setbacks, internal road alignment, drainage alignment, utility

layout, and residential/industrial plot subdivision.

**Exercise 14: Integrated Survey Case Study and Final Documentation**
Preparation of a complete survey drawing package including site plan, contour-layout combined drawing, accuracy checks, printing at correct scale, and final documentation.

# Department of Electrical and Electronics Engineering

The Department of Electrical and Electronics Engineering is introducing Mini Courses for Continuous Improvement (MCCI) to empower students with industry-relevant skills, enhance employability, and prepare them to excel in modern smart systems, circuit simulation, power electronics, and industrial automation domains.

**Objectives of Mini Courses for Continuous Improvement**

- Promote continuous learning through small, focused, and consistent academic interventions that enhance students' knowledge and skills.
- Provide flexible micro-learning opportunities that align with individual learning needs, career aspirations, and industry requirements.
- Enable learners to acquire specialized competencies and upskill efficiently without the constraints of long-duration traditional courses.
- Foster a culture of self-directed learning and lifelong professional development through accessible and diverse mini-course offerings.

**List of Mini courses offered in Electrical and Electronics Engineering**

| S.No | Course Code | Course Name | Offered Semester |
|---|---|---|---|
| 1 | MIACSD01 | MATLAB Smart Systems and Modelling | IV Semester |
| 2 | MIASSD01 | Circuit Simulation Using Tinkercad | |
| 3 | MIAPED03 | Power Electronic Circuit Simulation Using PLECS / MATLAB Simulink | VI Semester |
| 4 | MIASCD04 | SCADA and Industrial Automation | |

# COURSE DETAILS

| | |
|---|---|
| **Course Code** | **MIACSD01** |
| **Course Name** | **MATLAB Smart Systems and Modelling** |

**Course Overview**
MATLAB Smart Systems and Modelling focuses on the modelling, simulation, and analysis of intelligent engineering systems using MATLAB and Simulink. The course covers mathematical modelling, system dynamics, control system design, data analysis, and algorithm development for smart applications. It enables students to develop and simulate models of electrical, electronic, and energy systems, analyze system performance, and implement intelligent solutions, bridging theoretical concepts with practical applications in automation, renewable energy, and smart grid technologies.

**Course Content & Exercises**

**Exercise 1: MATLAB Environment and Basic Programming** – Introduction to MATLAB interface, command window, script files, and functions. Use of variables, operators, loops, and conditional statements. Visualization of results using basic plotting tools.

**Exercise 2: Mathematical Modeling of Dynamic Systems** – Development of first-order and second-order system models using differential equations. Representation using transfer functions in MATLAB. Analysis of time response characteristics.

**Exercise 3: Introduction to Simulink Modeling** – Creation of simple models using Simulink block diagrams. Use of integrator, gain, sum, and scope blocks. Simulation and observation of system outputs.

**Exercise 4: Modeling of Electrical Systems** – Simulation of RLC circuits in MATLAB/Simulink environment. Analysis of transient and steady-state responses. Study of system parameters on performance.

**Exercise 5: Modeling of Mechanical Systems** – Development of mass-spring-damper system models. Observation of displacement, velocity, and acceleration responses. Evaluation of damping effects on stability.

**Exercise 6: Control System Design** – Design and implementation of PID controller for closed-loop systems. Comparison of open-loop and closed-loop responses. Performance analysis based on rise time, settling time, and overshoot.

**Exercise 7: Smart Grid Component Modeling** – Modeling of distributed generation sources such as solar PV. Simulation of power output under varying conditions. Analysis of voltage and power characteristics.

**Exercise 8: Renewable Energy System Simulation** – Simulation of solar or wind energy conversion systems. Integration of power electronic interface models. Evaluation of system efficiency and dynamic response.

**Exercise 9: Electric Vehicle Subsystem Modeling** – Basic modeling of EV subsystems such as battery, DC motor, or inverter. Simulation of energy flow and performance characteristics. Analysis of system behavior under load variations.

**Exercise 10: Data Acquisition and Signal Processing –** Importing and processing real-time or recorded data in MATLAB. Application of filtering and signal analysis techniques. Interpretation of system performance from processed signals.

**Exercise 11: Optimization Techniques** – Parameter tuning using MATLAB optimization tools. Improvement of system response and stability. Comparative analysis before and after optimization.

**Exercise 12: State-Space Modeling and Analysis** – Representation of systems using state-space equations. Analysis of controllability, observability, and stability. Simulation of state responses.

**Exercise 13: Real-Time Simulation Concepts** – Introduction to hardware-in-the-loop (HIL) concepts. Understanding real-time modeling principles. Discussion on practical implementation scenarios.

**Exercise 14: Final Smart System Modeling Project** – Development of an integrated smart system model. Incorporation of modeling, control, and performance analysis. Preparation of structured technical documentation and results interpretation.

| | |
|---|---|
| **Course Code** | **MIASSD01** |
| **Course Name** | **Circuit Simulation Using Tinkercad** |

**Course Overview**

Circuit Simulation Using Tinkercad focuses on the design, simulation, and testing of basic electrical and electronic circuits using an interactive online platform. The course covers circuit components, schematic development, Arduino interfacing, sensor integration, and basic embedded programming. It enables students to build and simulate analog and digital circuits virtually, analyze circuit behavior, troubleshoot errors, and validate designs, bridging fundamental theory with hands-on practical learning in electronics and embedded systems.

**Course Content & Exercises**

**Exercise 1: Introduction to Tinkercad Interface** – Familiarization with Tinkercad workspace and circuit editor. Selection of components and proper wiring techniques. Understanding simulation controls and real-time testing features.

**Exercise 2: Basic Electrical Circuits** – Simulation of simple DC circuits using resistors and power sources. Verification of Ohm's Law through practical measurement. Use of virtual multimeter for voltage and current analysis.

**Exercise 3: Series and Parallel Circuits** – Design of resistor networks in series and parallel configurations. Measurement of voltage drops and current distribution. Comparison of theoretical and simulated results.

**Exercise 4: Diode and Rectifier Circuits** – Simulation of diode forward and reverse bias characteristics. Development of a half-wave rectifier using AC source. Observation of rectified output waveform.

**Exercise 5: Transistor as a Switch** – Implementation of BJT transistor as an electronic switch. Control of LED operation using base triggering. Analysis of switching behavior and current flow.

**Exercise 6: Logic Gates and Digital Circuits** – Implementation of basic logic gates (AND, OR, NOT, NAND, NOR). Verification of truth tables through simulation. Understanding digital logic fundamentals.

**Exercise 7: Combinational Logic Circuits** – Design of half-adder and full-adder circuits using logic gates. Verification of sum and carry outputs. Analysis of combinational logic operation.

**Exercise 8: Introduction to Arduino Programming** – Setup of Arduino environment within Tinkercad. Development of basic LED blinking program. Understanding digital input/output pin configuration.

**Exercise 9: Interfacing Push Button and LED** – Design of push button-controlled LED circuit. Implementation of Arduino code for input detection. Testing of switch-controlled output response.

**Exercise 10: Sensor Interfacing** – Simulation of temperature sensor (TMP36) with Arduino. Reading analog input values and converting to temperature. Display of output using serial monitor.

**Exercise 11: Motor and Actuator Control –** Interfacing DC motor or servo motor with Arduino. Programming for speed or position control. Observation of actuator response through simulation.

**Exercise 12: LCD Display Interface** – Interfacing 16x2 LCD display with Arduino. Programming to display sensor or system data. Testing real-time output visualization.

**Exercise 13: Traffic Light Controller –** Development of traffic signal system using LEDs. Implementation of sequential control using Arduino programming. Verification of timing and signal transitions.

**Exercise 14: Final Mini Project and Documentation –** Development of a complete embedded system simulation. Integration of sensors, actuators, and control logic. Preparation of circuit diagram, source code, simulation results, and structured technical documentation.

| | |
|---|---|
| **Course Code** | **MIAPED03** |
| **Course Name** | **Power Electronic Circuit Simulation Using PLECS / MATLAB Simulink** |

**Course Overview**

Power Electronic Circuit Simulation Using PLECS / MATLAB Simulink focuses on modelling and simulating power electronic converters and control systems using industry-standard tools. The course covers rectifiers, DC–DC converters, inverters, PWM techniques, and closed-loop control design. It enables students to analyze switching behavior, harmonics, and system performance through simulation, bridging theoretical concepts with practical applications in renewable energy, motor drives, and electric vehicle systems.

**Course Content & Exercises**

**Exercise 1: Simulation Environment Setup** – Introduction to PLECS / MATLAB Simulink interface and workspace environment. Creation of new models with proper selection of solver and simulation parameters. Familiarization with component libraries and basic measurement blocks.

**Exercise 2: Single-Phase Half-Wave Rectifier** – Modelling of a diode-based half-wave rectifier circuit. Observation of input and output voltage/current waveforms under resistive load. Calculation of average output voltage and ripple factor.

**Exercise 3: Single-Phase Full-Wave Rectifier** – Development of a center-tapped or bridge full-wave rectifier model. Comparison of output performance with half-wave rectifier. Evaluation of ripple reduction and rectification efficiency.

**Exercise 4: Controlled Rectifier Using SCR** – Simulation of a single-phase controlled rectifier using SCR devices. Implementation of firing pulse generation with variable firing angle. Analysis of output voltage control characteristics.

**Exercise 5: DC–DC Buck Converter** – Design and simulation of a step-down (buck) converter circuit. Study of duty cycle variation on output voltage regulation. Analysis of inductor current ripple and transient response.

**Exercise 6: DC–DC Boost Converter** – Modelling of a step-up (boost) converter with switching control. Observation of voltage amplification based on duty cycle variation. Evaluation of steady-state and dynamic performance.

**Exercise 7: DC–DC Buck-Boost Converter** – Simulation of a buck-boost converter for voltage inversion and regulation. Study of output polarity and magnitude under different duty cycles. Analysis of converter operating modes.

**Exercise 8: PWM Generation Techniques** – Implementation of sinusoidal and carrier-based PWM techniques. Generation of gating signals for power semiconductor switches. Observation of switching waveforms and modulation index effects.

**Exercise 9: Single-Phase Voltage Source Inverter (VSI)** – Modelling of a single-phase inverter using IGBT/MOSFET switches. Application of PWM control for AC output generation. Analysis of output voltage waveform and Total Harmonic Distortion (THD).

**Exercise 10: Three-Phase Voltage Source Inverter –** Simulation of a three-phase inverter with SPWM control. Observation of line and phase voltage waveforms. Evaluation of harmonic content and balanced operation.

**Exercise 11: Closed-Loop Control of DC–DC Converter** – Design of a feedback control system using a PI controller. Implementation of voltage regulation under load variations. Analysis of system stability and dynamic response.

**Exercise 12: Induction Motor Drive Simulation** – Modelling of an inverter-fed induction motor drive system. Observation of speed response and torque characteristics. Study of dynamic performance under varying load conditions.

**Exercise 13: Harmonic Analysis and Power Quality** – Use of FFT analysis tools in Simulink / PLECS. Calculation of harmonic spectrum and THD values. Study of filtering techniques for power quality improvement.

**Exercise 14: Final Simulation Project and Documentation –** Development of a complete converter system with appropriate control strategy. Validation of performance through waveform and efficiency analysis. Preparation of structured technical documentation and results interpretation.

| Course Code | MIASCD04 |
|---|---|
| Course Name | SCADA and Industrial Automation |

**Course Overview**

SCADA and Industrial Automation focuses on the design, monitoring, and control of industrial processes using Supervisory Control and Data Acquisition (SCADA) systems and automation technologies. The course covers PLC programming, HMI development, industrial communication protocols, sensors and actuators, and real-time data acquisition. It enables students to design and simulate automated control systems, monitor industrial parameters, and analyze system performance, bridging theoretical control concepts with practical applications in power plants, manufacturing industries, and smart infrastructure systems.

**Course Content & Exercises**

**Exercise 1: Introduction to Industrial Automation Architecture –** Study of the automation pyramid and hierarchical control structure in industries. Understanding the roles of PLC, SCADA, HMI, sensors, actuators, and industrial communication networks. Analysis of integrated automation workflow in manufacturing and process plants.

**Exercise 2: PLC Hardware Familiarization** – Identification of PLC hardware components including CPU, input/output modules, and power supply. Understanding wiring practices and I/O addressing. Demonstration of basic PLC setup and configuration.

**Exercise 3: Basic PLC Programming – Ladder Logic** – Development of simple ladder logic programs using logic gates (AND, OR, NOT). Implementation of timers and counters in control circuits. Testing and debugging of basic PLC programs.

**Exercise 4: Motor Control Using PLC** – Programming of DOL starter control using ladder logic. Implementation of forward-reverse control with electrical interlocking. Verification of safe motor operation through simulation.

**Exercise 5: Timer and Counter Applications** – Design of sequential control systems using timers and counters. Development of process control logic for industrial operations. Simulation and analysis of sequence timing accuracy.

**Exercise 6: Analog I/O and Sensor Integration –** Interfacing temperature, pressure, or level sensors with PLC analog modules. Scaling and processing of analog input signals. Monitoring and control of process variables.

**Exercise 7: Introduction to SCADA Software –** Understanding SCADA system architecture and communication structure. Creation of tags for real-time data acquisition. Configuration of PLC-SCADA communication.

**Exercise 8: HMI Screen Development –** Design of graphical HMI screens for monitoring and control. Integration of push buttons, indicators, and trend displays. Testing user interaction with simulated processes.

**Exercise 9: Alarm and Event Management –** Configuration of alarm limits and event triggers in SCADA. Implementation of event logging and acknowledgment features. Analysis of alarm handling for process safety.

**Exercise 10: Industrial Communication Protocols –** Implementation of Modbus or Profibus communication protocols. Establishment of data exchange between PLC and SCADA systems. Verification of reliable communication performance.

**Exercise 11: Data Logging and Trend Analysis –** Configuration of historical data storage in SCADA systems. Visualization of trends for process monitoring. Evaluation of system performance using recorded data.

**Exercise 12: Supervisory Control Implementation –** Development of supervisory control logic for automated processes. Integration of PLC control with SCADA monitoring. Testing centralized control strategies.

**Exercise 13: Industrial Safety and Interlocking Systems –** Implementation of safety interlocks and emergency stop logic in PLC. Design of fail-safe programming techniques. Verification of safe system shutdown procedures.

**Exercise 14: Final Automation Project and Documentation –** Development of a complete mini industrial automation project. Integration of PLC program, SCADA interface, and I/O mapping. Preparation of system architecture diagram and structured technical documentation.

## Industry Requirements and Emerging Skill Demands

The rapid pace of technological advancement, digital transformation, and evolving workplace practices has significantly reshaped industry expectations across all sectors. Employers increasingly seek graduates who possess a combination of strong technical knowledge, practical problem-solving abilities, professional competencies, and adaptability to emerging technologies. Beyond domain expertise, industries emphasize innovation, interdisciplinary collaboration, effective communication, critical thinking, and lifelong learning capabilities.

To address these evolving requirements, Mini Courses for Continuous Improvement are designed to bridge identified skill gaps and provide focused learning opportunities that align academic learning with current and future workforce demands. The table shows industry requirements and emerging skill demands across professional domains.

| Industry Requirement | Emerging Skill Demand 1 | Emerging Skill Demand 2 | Emerging Skill Demand 3 | Emerging Skill Demand 4 | Emerging Skill Demand 5 |
|---|---|---|---|---|---|
| Digital Transformation | Digital Literacy | Data Interpretation | Technology Adoption | Automation Awareness | Continuous Learning |
| Emerging Technologies | AI & Analytics | Cloud Computing | IoT Applications | Cybersecurity Awareness | Industry 4.0 Readiness |
| Engineering & Technical Excellence | Domain Expertise | Design Thinking | System Integration | Technical Problem Solving | Innovation Skills |
| Professional Competencies | Communication Skills | Teamwork & Collaboration | Leadership | Project Management | Ethical Practices |
| Future Workforce Readiness | Critical Thinking | Adaptability | Creativity | Entrepreneurship | Lifelong Learning |

## Key Findings:

The mini courses for continuous improvement initiative reflects the institution's commitment to fostering continuous learning, industry relevance, and student competency development. The courses provide focused learning opportunities in emerging technologies, advanced technical domains, professional skills, and interdisciplinary areas. Through outcome-based learning, practical exposure, and industry-aligned content, it enables students to enhance their knowledge, strengthen employability skills, and prepare for evolving academic and professional challenges.

**The summary of Key Findings is as follows:**

1. **Industry expectations are continuously evolving**
   Rapid technological advancements and changing workplace requirements demand graduates who possess updated technical knowledge, practical skills, and the ability to adapt to emerging trends.

2. **Department-driven course offerings address skill gaps**
   Department-wise MICC courses enable targeted interventions that address specific industry requirements, emerging trends, and competency gaps relevant to individual disciplines.

3. **Domain-specific and interdisciplinary skills are equally important**
   Modern industries require professionals with strong domain expertise along with interdisciplinary competencies that enable innovation, collaboration, and problem-solving.

4. **Practical and application-oriented learning is essential**

Hands-on activities, tool-based learning, case studies, simulations, and real-world applications significantly improve students' understanding and industry readiness.

5. **Professional competencies remain critical**
   Communication, teamwork, leadership, critical thinking, adaptability, ethical practices, and project management continue to be highly valued across all professional sectors.

6. **Flexible learning pathways support student development**
   Short-duration and focused learning modules provide students with opportunities to explore specialized topics and acquire additional competencies without disrupting their regular academic schedule.

7. **Continuous improvement requires periodic skill enhancement**
   Regular exposure to contemporary technologies, industry practices, and emerging knowledge domains helps students remain competitive and prepared for future career opportunities.

8. **MICC supports lifelong learning and professional growth**
   The MICC framework promotes self-learning, innovation, curiosity, and continuous professional development, preparing students for higher education, research, entrepreneurship, and successful careers.

**LEARN • EXPLORE • UPSKILL • INNOVATE • ACHIEVE • SUCCEED**
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