CONSTRUCTION EQUIPMENT

ENIE 325

Lecture : 3 **Year : III**
Tutorial : 2 **Part : I**
Practical : 1

Course Objectives:
The objective of this course is to provide concepts on construction equipment with a primary focus on mechanical systems. It covers functional principles, power transmission mechanisms, hydraulic and pneumatic systems, maintenance procedures, safety considerations, and equipment management practices. Students will gain familiarity with selected categories of construction machinery, including their general technical specifications, selection criteria, repair and maintenance procedures, safety features, and cost analysis.

1 Introduction (8 hours)

1.1 Earth moving equipment: Dozers, loaders, excavators, scrapers
1.2 Trucks and hauling equipment: Rigid frame, articulated, bottom dump, and side dump
1.3 Finishing equipment: Graders, compaction equipment, asphalt paving machine
1.4 Crane and lifting equipment: Mobile cranes, fixed cranes
1.5 Material handling equipment: Lifting and lowering, horizontal motion, combined motion, forklift

2 Transmission Systems (8 hours)

2.1 Clutches: Frictional (Dry, wet), hydrodynamic, torque converter
2.2 Gearbox: Sliding mesh, constant mesh, synchro mesh, planetary
2.3 Manual transmission system: Sliding mesh, constant mesh, syncro-mesh gearbox
2.4 Automatic transmission system: Planetary gearbox and continuously variable transmission (CVT) system
2.5 Powershift transmission system: Dual clutch system, automatic transmission system
2.6 Hydrostatic transmission system
2.7 Final drive

3 Hydraulic Systems (6 hours)

3.1 Basic principle of hydraulics
3.2 Applications of the hydraulic system

3.3 Components of the hydraulic system and their functions
3.4 Types of hydraulic systems and their working principle: Open and closed center systems
3.5 Hydraulic pumps: Function, types, and working principle
3.6 Hydraulic motors: Function, types, and working principle
3.7 Valves: Functions, types, and working principle
3.8 Accumulators: Purpose, types, and working principle
3.9 Hydraulic fluids: Purposes, properties, specifications, and storage

4 Pneumatic Systems (4 hours)

4.1 Basic principle of pneumatics
4.2 Preparation of compressed air, its properties, and functions
4.3 Applications of the pneumatic system
4.4 Components of pneumatic system and their functions
4.5 Types of air compressors
4.6 Valves and their types
4.7 Actuators: Purposes, types, and working principles

5 Hydraulic and Pneumatic Circuits (6 hours)

5.1 Circuit types: Series and parallel circuits (Cylinders and motors)
5.2 Reciprocating circuit
5.3 Accumulator circuit
5.4 Speed control circuit
5.5 Sequencing circuit
5.6 Impulse operation and speed control circuit
5.7 Time delay circuit
5.8 Fail-safe circuit
5.9 Troubleshooting and maintenance

6 Electronic Components of Hydraulic System (2 hours)

6.1 Sensors, actuators, and electronic control units
6.2 Microprocessor control hydraulic system circuit diagram
6.3 Functions of the pump and valve controller and the engine controller

7 Maintenance Management (4 hours)

7.1 Needs of maintenance and repair
7.2 Equipment maintenance systems
7.3 Maintenance techniques (Preventive, predictive, breakdown)
7.4 Maintenance practices
7.5 Workshop manual
7.6 Spare parts manual
7.7 Maintenance cost

7.8 Spare parts management
7.9 Diagnosis and testing of the system

8 Safety in Operation and Maintenance (3 hours)

8.1 Safety inspections and safety precautions
8.2 Personal, equipment, and workshop safety practices

9 Management of Construction Equipment (4 hours)

9.1 Equipment acquisition: Purchasing, leasing, and hiring
9.2 Selection criteria
9.3 Estimation of owning cost, operating cost, and hiring cost
9.4 Equipment utilization analysis
9.5 Marketing aspect of construction equipment
9.6 Procurement methods and practices
9.7 Inspection, testing, and commissioning

Tutorial (30 hours)

1. Productivity calculation of construction equipment
2. Design and drawing of simple hydraulic circuits
3. Design and drawing of simple pneumatic circuits
4. Numerical problems on costs of equipment

Practical (15 hours)

1. Demonstration of the hydraulic system
2. Demonstration of pneumatic system
3. Demonstration of the transmission system
4. Procurement assignments
5. Maintenance documentation (Requisition, log sheet, and job costing)

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1	8	10
2	8	10
3	6	10
4 and 7	8	10
5	6	10
6, 8 and 9	9	10
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Sharma, S.C. (2008). Construction equipment and its management. Khanna Publishers.
2. Esposito, A. (2013). Fluid power with applications. Pearson Education.
3. Peurifoy, R.L., Schexnayder, C.J. (2023). Construction planning, equipment and methods. McGraw-Hill Education.
4. Bernold, L.E. (2013). Construction equipment and methods: Planning, innovation, safety. Wiley.
5. Srivastava, S.K. (2010). Maintenance engineering: Principles, practices and management. S. Chand & Company.

FOOD TECHNOLOGY AND FOOD PROCESS ENGINEERING

ENIE 326

Lecture : 3 **Year : III**
Tutorial : 2 **Part : I**
Practical : 1

Course Objectives:
The objective of this course is to introduce food industry, covering food composition, key processing technologies, and quality control. It focuses on applying industrial engineering principles, including process design, optimization, automation and supply chain management, to food manufacturing systems.

1 Introduction (3 hours)

1.1 Global food industry: Scope and importance
1.2 Role of industrial engineers in food manufacturing
1.3 Overview of food components
1.4 Food microbiology and enzymes

2 Principles of Food Processing (12 hours)

2.1 Classification of food: Perishable, semi-perishable and non-perishable
2.2 Concept of hurdle technology
2.3 Mass and energy balance in food processing unit operations
2.4 Thermal processing principles: Pasteurization, sterilization, blanching
2.5 Preservation by lowering temperatures: Chilling and freezing
2.6 Preservation by water removal: Evaporation, dehydration and freeze drying
2.7 Aseptic processing
2.8 High pressure food processing, high intensity pulse electric field, ohmic heating, microwave heating

3 Operations in Food Processing (12 hours)

3.1 Mechanical separation: Filtration, sedimentation, centrifugation
3.2 Size reduction and mixing
3.3 Extrusion and forming processes
3.4 Packing technologies:
  3.4.1 Materials and methods
  3.4.2 Controlled atmosphere packaging
  3.4.3 Modified atmosphere packaging

4 Food Quality, Safety and Sanitation (12 hours)

4.1 Raw materials inspection, process inspection and final inspection

4.2 Hazard analysis and critical control points, halal, kosher standards
4.3 Good manufacturing practices
4.4 Good hygiene practices
4.5 Sanitation standard operating procedures
4.6 Total quality management and total productive maintenance
4.7 Quality assurance and control: Sensory evaluation, laboratory testing and instrumentation methods

5 Industrial Engineering Application in Food Plants (6 hours)

5.1 Machinery and equipment in post-harvest technology
5.2 Plant design and layout for food processing
5.3 Process flow diagramming and optimization in food production lines
5.4 Automation, sensors and process control in food processing
5.5 Supply chain and inventory management for perishable goods
5.6 Productivity and waste reduction in food operations

Tutorial (30 hours)

1. Calculations of nutritional facts calorie
2. Classification of food based on the shelf life
3. Calculations of mass and energy balance calculations
4. Warehouse sizing for raw materials
5. Production line bottleneck and throughput
6. Payback period for automated packing systems

Practical (15 hours)

1. Proximate analysis of food (Moisture, fat, protein content)
2. Moisture test of instant moisture meters
3. Preparation of basic food production line layout
4. Thermal processing experiment (Canning or pasteurization)
5. Mini project: HACCP plan for a simple food product (Pasteurized milk)
6. Food factory visits

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1	3	5
2	12	15
3	12	15
4	12	15
5	6	10
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Singh, R.P., Heldman, D.R. (2014). Introduction to food engineering. Academic Press.
2. Fellows, P.J. (2017). Food processing technology: Principles and practice. Woodhead Publishing.
3. Earle, R.L., Earle, M.D. (1983). Unit operations in food processing (Latest Edition). Pergamon Press.
4. Toledo, R.T. (2007). Fundamentals of food process engineering. Springer.
5. Maroulis, Z.B., Saravacos, G.D. (2003). Food process design. CRC Press.
6. Motarjemi, Y., Lelieveld, H. (Eds.). (2014). Food safety management: A practical guide for the food industry. Academic Press.

REFRIGERATION AND HEATING, VENTILATION AND AIR CONDITIONING

ENIE 327

Lecture : 3 **Year : III**
Tutorial : 2 **Part : I**
Practical : 1

Course Objectives:
The objective of this course is to provide fundamental concepts of different types of refrigeration, heating, ventilation and air conditioning system used in the industry. After the completion of this course, students will be able to design the refrigeration and air-conditioning system.

1 Refrigeration (5 hours)

1.1 Historical evolution
1.2 Reverse Carnot cycle: Construction and working principle
1.3 Bell-Coleman cycle: Construction and working principle
1.4 Types of refrigeration
1.5 Coefficient of performance
1.6 Methods to improve coefficient of performance

2 Refrigerants (2 hours)

2.1 Classification
2.2 Properties of an ideal refrigerant
2.3 Properties and pressure-temperature charts of various refrigerants
2.4 Ozone depletion, global warming potential issues
2.5 Montreal protocol

3 Food Preservation and Cryogenics (4 hours)

3.1 Factors contributing to food spoilage
3.2 Methods of food preservation
3.3 Milk chilling and pasteurization
3.4 Limitations of vapor compression system
3.5 Multistage and cascade systems
3.6 Liquefaction of gases
3.7 Load calculation for cold rooms

4 Flow Control Devices (4 hours)

4.1 Capillary tube

4.2 Hand expansion valve
4.3 Automatic expansion valve
4.4 Thermostatic expansion valve
4.5 Thermal-electric expansion valve
4.6 Electronic expansion valve
4.7 High-side and low-side valve
4.8 Pressure relief valve
4.9 Solenoid valve

5 Psychrometry (4 hours)

5.1 Psychrometry and psychrometric properties
5.2 Variation of psychrometric properties with altitude
5.3 Psychrometric relation: Dalton's law of partial pressure
5.4 Measurement of dry bulb temperature, wet bulb temperature and relative humidity
5.5 Psychrometric chart and its uses
5.6 Psychrometric processes: Sensible heating, sensible cooling, humidification, dehumidification, cooling with dehumidification, cooling with adiabatic humidification, heating with humidification and their representation on psychrometric chart

6 Thermal Comfort and Indoor Air Quality (4 hours)

6.1 Thermal comfort
6.2 Thermal exchange of body with environment
6.3 Physiological hazard resulting from heat
6.4 Factor affecting human comfort
6.5 Effective temperature
6.6 Comfort chart
6.7 Indoor air quality
6.8 Air stratification
6.9 Indoor air quality control

7 Air-Conditioning System (6 hours)

7.1 Classification
7.2 Direct expansion air-conditioning system
7.3 All water air-conditioning system
7.4 All air air-conditioning system
7.5 Air water-air-conditioning system
7.6 Components: Chiller, cooling tower, heat pumps, VRF/VRV, AHU, FCU
7.7 Centralized, split and package systems
7.8 Sensible heat factor

8 System Load Determination (6 hours)

8.1 Design condition
8.2 Heating and cooling load calculation
  8.2.1 Cooling load temperature difference method
  8.2.2 Radiant time series method
8.3 Selection of indoor and outdoor unit
8.4 Use of cooling loads in system sizing
8.5 E20 sheet, HAP

9 Air Distribution Systems (6 hours)

9.1 Classification of duct
9.2 Duct design and duct sizing
9.3 Construction of duct
9.4 Components of air distribution system: Fan, air filter, eliminator, heating coil, cooling coil, humidifier, dehumidifier, dampers, grill, diffuser
9.5 Acoustic and vibration in HVAC system

10 Energy Efficient Building (4 hours)

10.1 Thermal insulation and green building
10.2 Energy conservation and green building (LEED, ECBC, passive design)
10.3 Parameters in energy efficiency
10.4 Strategies for energy efficient building design
10.5 Building energy management system

Tutorial (30 hours)

1. Calculation of power, COP using PH charts of vapour compression refrigeration systems
2. Numerical problems related to Bel-Coleman cycle, cold storage system
3. Numerical example of psychrometric charts and plotting air conditioning process in psychrometric charts
4. Heat load determination of system and system sizing and selection
5. Heat load estimation for class room, workshop design duct routs, and select AHU and fan size

Practical (15 hours)

1. Study of humidifier and dehumidifier and its capacity determination
2. Study of vapour absorption refrigeration system and its COP and capacity determination
3. Study of fan and duct system in air conditioning
4. Refrigerant charging and discharging system
5. Determination of system load in HVAC system
6. Drafting of HVAC system using AutoCAD
7. Study of evaporative cooling

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1	5	10
2	2	4
3	4	4
4	4	4
5	4	8
6	4	4
7	6	10
8	6	6
9	6	6
10	4	4
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Arora, V.M., Domkundwar, S.C. (2017). A course in refrigeration and air conditioning. Dhanpat Rai & Co.
2. Prasad, M. (2015). Refrigeration and air conditioning. New Age International Publishers.
3. Ballaney, P.L. (1972). Refrigeration and air-conditioning (Latest Edition). Khanna Publishers.
4. Khurmi, R.S., Gupta, J.K. (2022). A textbook of refrigeration and air conditioning. S. Chand.
5. Arora, C. P. (2010). Refrigeration and air conditioning. Tata McGraw-Hill.
6. Vedavarz, A., Kumar, S., Hussain, M.I. (2007). HVAC: The handbook of heating, ventilating and air-conditioning for design and implementation. Industrial Press.

APPLIED COMPUTER AIDED DESIGN

ENIE 328

Lecture : 3 **Year : III**
Tutorial : 2 **Part : I**
Practical : 1

Course Objectives:
The objective of this course is to provide students with theoretical and practical knowledge of computer aided design(CAD). It emphasizes on geometrical modelling, mathematical representation of curves, surfaces and solids, parametric modelling, assembly design, drafting, and integration with modern manufacturing technologies. Students will gain hands on experience CAD software tools and develop skills in creating, analyzing and modifying engineering designs.

1 Introduction (3 hours)

1.1 Definitions of computer aided design (CAD), computer aided manufacturing (CAM) and computer aided engineering (CAE)
1.2 History and its application
1.3 Classification of CAD systems: Standalone, integrated and cloud-based CAD
1.4 CAD system and software modules: Part module, assembly module, draft module, analysis module
1.5 Role of CAD in engineering: Design optimization, product lifecycle, design-for -manufacture, role in industrial engineering

2 Geometric Modelling Fundamentals (2 hours)

2.1 Geometry and topology
2.2 Coordinate systems (Cartesian, cylindrical, spherical)
2.3 Parametric and non-parametric curves (Definition and example)
2.4 Types of geometric modelling: Wire frame, surface and solid modeling, advantages and limitations

3 Mathematical Representation of Curves and Surfaces (12 hours)

3.1 Parametric representation of analytic curves: Lines, circles, ellipses, parabolas, hyperbolas
3.2 Parametric representation of synthetic curves: Hermite, Bezier, B-spline, rational curves, non-uniform rational B-spline (NURBS) curve (Only basic treatment)
3.3 Surface representations (Only basic treatment): Planar surfaces, ruled surfaces, surfaces of revolution, Bezier and B-spline surfaces

3.4 Curve and surface manipulation: Evaluating points on curves, blending, segmentation, trimming, intersection, lofting, sweeps

4 Solid Modeling and Feature Based Design (10 hours)

4.1 Fundamentals of solid modelling: Set theory, Boolean operations (Union, intersection, subtraction), half-space modeling
4.2 Solid modelling techniques: Boundary representation (B-Rep), Euler-Poincare law, winged edge, half edge data structure, constructive solid geometry (CSG)
4.3 Feature-based modelling, assembly and constraints, extrusion, revolutions, sweeps, lofting, blending (or design intent)
4.4 Manipulation and editing of entities: Selection methods (Dragging, clipping, trimming, stretching, offsetting, pattern, copying, deleting, regenerating, measuring, mirroring, scaling)
4.5 Scripting and MACROS in CAD

5 Drafting and GD&T (6 hours)

5.1 2D drafting from 3D models
5.2 Standard for dimensioning and tolerance (ISO, ASME)
5.3 Annotation, labeling, section views and exploded views
5.4 Technical drawing best practices for manufacturing and assembly

6 CAM Integration with Manufacturing and Recent Technology (12 hours)

6.1 Integration of CAD and CAM, automation in manufacturing execution system (MESS)
6.2 CAD/CAM data exchange: IGES, STEP, STL, DXF, PDES, ACIS, Parasolid
6.3 Fundamentals of machine programming: Computer numeric control (CNC), automatically programmed tools (APT), G-codes, M-codes, toolpath generation
6.4 Rapid prototyping and manufacturing: Stereo lithography, Fused Deposition Method (FDM), solid ground curing, 3D printing
6.5 Virtual Engineering: Virtual design, cloud-based CAD, generative design, advanced simulation and analysis, virtual and augmented reality
6.6 Case studies of CAD application in industrial engineering, mechanical engineering and automotive engineering design

Tutorial (30 hours)

1. Overview of CAD software, its interface and their applications
2. Geometric modeling exercises: Wireframe, Surface and solid creation
3. Numerical related to parametric representation of synthetic curves
4. Curve and surface operations: Lofting, sweeps, blending, trimming
5. Feature-based modeling techniques: Extrusion, revolution, lofting, sweeping

6. Solid Modeling exercises: Boolean operations, feature based design, assemblies
7. Drafting Exercise: Dimensioning, annotation, section views, exploded views
8. Basics of CNC programming: G-codes and M-codes
9. Scripting and MACROS in CAD
10. CAM integration exercises: Toolpath creation, CNC simulation, rapid prototyping demonstration

Practical **(15 hours)**

1. Creating basic 3D parts
2. Exercise on extrusion, revolution, lofting and sweep operation
3. Exercise on feature-based design: Holes, slots, fillets, chamfers, patterns, mirror
4. Exercise on threading, bores and tappings
5. Exercise on part assembly
6. Exercise on drafting and annotation
7. Exercise on sheet metal operations
8. Exercises on rapid prototyping
9. Capstone project: Model and assemble a mechanical component using CAD software

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1 and 2	5	8
3	12	18
4	10	12
5	6	6
6	12	16
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Zeid, I., Sivasubramanian, R. (2009). CAD/CAM: Theory and practice. McGraw-Hill.
2. Saxena, A., Sahay, B. (2005). Computer aided engineering design. Springer.
3. Amirouche, F.M.L. (2004). Principles of computer-aided design and manufacturing. Pearson Prentice Hall.
4. Lee, K. (1999). Principles of CAD/CAM/CAE (Latest Edition). Pearson.
5. Groover, M.P., Zimmers, E.W., Jr. (2013). CAD/CAM: Computer-aided design and manufacturing. Pearson Education.