

## VII Semester

### REFRIGERATION & AIR CONDITIONING M 401

#### UNIT I : SECTION - I REFRIGERATION

Introduction: Definition, history of refrigeration, standard rating of refrigerating machines, C.O.P. of refrigerating machines, types of refrigerating machines, types of refrigeration, ice-refrigeration, evaporative refrigeration, air compression refrigeration, vapour compression refrigeration, steam ejector refrigeration. Absorption refrigeration, vortex tube refrigeration and thermoelectric refrigeration. Principle of working of each type.

Air compression refrigeration: Basic air compression cycle. Flow diagram its working and function of its main components. Carnot and Bell Coleman air refrigeration cycles, their representation, open and closed cycles-relative merits and demerits. Air cycle systems for aircraft and missiles, numerical examples.

#### UNIT II :

Vapour compression refrigeration: Theoretical vapour compression cycle, its working and representation on P-H, T-S and P-V diagrams. Coefficient of performance, practical vapour compression cycle, its main point of difference as compared to theoretical cycle, dry and wet compression, their relative merits and demerits, purpose of sub cooling of the high pressure liquid and superheating the low pressure vapour. Effect of suction and delivery pressures, volumetric efficiency, calculation of COP, power etc. COP as heat pump, Components their types and relative merits. Advanced vapour comparison systems. Principle of working and relative merits. Single evaporator advanced cycle of vapour compression refrigeration systems with simple numerical examples.

#### UNIT III :

Absorption Refrigeration System: Simple absorption systems, practical system-its main points of difference and improvements. Principle of working and relative merits. Electrolux refrigerator applications.

Steam Ejector Refrigeration: Principles of working, simple cycle of operation, description and working of simple system. Relative merits and demerits, limitations, applications.

Refrigerants: Requisites of an ideal refrigerant, properties of commonly used refrigerants ammonia, Freon-12, Freon-22 etc. Alternate eco friendly refrigerant.

Production of low Temperature(Cryogenics): Limitations of vapour compression system for the production of low temperature. Multi stage system, cascade system. Production of solid CO<sub>2</sub>. Joule Thomson effect and liquification of gases. Application of

low temperature. Vortex Tube and Thermo-electric System: Principles of working vortex tube refrigeration, stage of development, limitations and applications, principles of working of thermoelectric refrigeration system, limitations and applications.

#### **UNIT IV : AIR CONDITIONING**

Introduction: Definition, need for air conditioning, modes of heat rejection from human body and their relative importance on human comfort under different weather conditions. Main duties of a good air conditioning system, relative importance of each of these on human comfort and health.

Psychometry: Definition, properties of air, vapour mixtures, definitions of psychometric properties, representation of psychometric properties on chart, psychometric processes and their representation on psychometric chart for calculations.

Various types of air conditioning systems, main features of each type of system, their field of applications and relative merits and demerits. Description and principle of working of each of these systems.

#### **UNIT V :**

Load calculations (comfort air conditioning): Sources of heat and moisture gains as applied to summer air conditioning. Their relative importance in various weather conditions and applications, consideration in designing a building to be air conditioned for minimizing the heat and moisture loss. Sensible heat factor. By pass factor, room apparatus & coil apparatus, dew point, sources of heat and moisture loss in winter air conditioning, their relative importance. Methods of reducing winter air conditioning load.

Industrial air conditioning: Purpose of industrial air conditioning, justification of industrial air conditioning, components of cooling loads for typical applications e.g. cold storage, considerations in designing of industrial air conditioning system, discussions of typical applications. Special features of air conditioning systems for commercial and other similar buildings supermarkets, cinema halls, hospitals, offices, schools etc.

#### **Books and References:**

1. Refrigeration and Air-conditioning by P.L. Balaney
2. Refrigeration and Air-conditioning by S. Domkundwar & C. Arora
3. Refrigeration and Air-conditioning by C.P. Arora

## **ADVANCED MACHINE DESIGN M402**

*Note:* Weightage of Unit I and Unit II is 25% each and that of Unit III is 50% in the final examinations.

### **UNIT I**

Residual stresses, causes, manufacturing process causing thermal gradient, impact etc. Contact stresses and Hertzian stresses. Optimization in design, economic consideration, human considerations, stiffness and rigidity considerations in design, shock and impact considerations in design.

### **UNIT II**

Wear consideration in design, tribology, concept of friction, wear and lubrication, effect of surface films, designing for wear life, erosive and corrosive wear. Creativity in design and alternative design. Product design, different modules of design theory. Aesthetic form, shape and colour. Design against fracture.

### **UNIT III**

Detailed design and working drawing:

Petrol Engine/Diesel Engine

Lathe/ Milling /Drilling Machine

and, computer aided design of one assembly from the above.

### **Books and References:**

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|----------------------------------|----------------------------|
| 1. Engineering Design            | G.E. Deiter                |
| 2. Handbook of Mechanical Design | G.M.Maitra and L.V. Prasad |
| 3. Machine Tool Design           | N.K. Mehta                 |
| 4. Machine Design                | Robert L. Norton           |
| 5. Engineering Tribology         | J.A.Williams               |
| 6. I.C. Engines                  | Richard Stone              |
| 7. Mechanical Engineering Design | J.E. Shigley               |
| 8. Product Design                | Chitale & Gupta            |
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## **PRODUCTION ENGINEERING**

### **M 403**

#### **UNIT-I :**

Metal cutting theory, geometry of cutting tools, metal machining, chip formation, types of chips, force analysis, velocity relationship, stress and strain analysis, power and energy relationships, thermal aspects, dynamometers for turning and drilling.

#### **UNIT-II :**

Machinability: Evaluation of machinability, tool life, flank wear, crater wear, cutting forces, surfaces finish, economics of metal machining, functions of cutting fluids, requirements of good cutting fluid, cutting tool materials.

#### **UNIT-III :**

Machine Tools System : Design analysis of machine tools, elements, structure, slideways and guides, spindle unit drives in machine tools, layout of gear box, stepped regulators, stepless regulators, hydraulic regulators.

Tooling principles and tool layouts for turrets, automates, operation planning considerations, designing of cams.

#### **UNIT-IV :**

Tool Design: Design of single point cutting tools, rigidity, design of chip breakers, dynamic chip breaking, design of press dies, component of die, cutting action in a die, clearance, cutting forces, shear, center of pressure.

Jigs and Fixtures: Usefulness of jigs and fixtures, principles of design, locating and clamping, diamond pin locator, jig bushes, drill jigs, milling, turning, boring and broaching fixtures, assembly fixtures, welding fixtures, indexing devices, materials for jigs and fixtures, economics of jigs and fixtures.

#### **UNIT-V :**

Standardisation, interchangeability, limits, fits, BIS, BSS and naval system, selection of fits as per Indian standards, metrology, various types of comparators, design of limit gauges, tolerance, wear allowances and quality control. Basic concepts.

Unconventional machining processes, need for unconventional machining method, ultrasonic, electrochemical, electrospark and abrasive jet machining, NC & CNC machines.

#### **Books and References:**

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|----|---------------------------------|---------------|
| 1. | A Text Book of Production Engg. | Pandey, Singh |
| 2. | Tool Design                     | Donaldson     |
| 3. | Production Technology           | H.M.T.        |
| 4. | Production Technology           | R.K. Jain     |
| 5. | Metal Cutting Principles        | Bhattacharya  |
| 6. | Machine Tools                   | S.K. Basu     |

**ELECTIVE – I MATERIALS HANDLING  
M 411**

**UNIT-I:**

Materials handling : General introduction, definition of terms i.e. batched goods, charged pallet ratio, general cargo, handling, integrated transport, line load etc.

Material handling: Engineering and economic factors, relationship to plant layout. Selection of material handling equipment. Types of equipments and their maintenance.

**UNIT-II:**

Unrestricted Equipment: General information, counterbalancing of trucks, powered stokers, order pickers, side loader and forwarding trucks, straddle carriers and mobile lifting frame, hand pallet trucks and stokers, air cushion handling frames, carts and trolleys.

**UNIT-III:**

Area restricted: General information on line restricted material handling equipment. Different type of conveyers like roller, wheel, belt, slat, chain, overhead rail etc.

**UNIT-IV:**

Railmounted trolleys, trolley and tractors, automatically guided vehicles, lift, elevators, other equipment, sorting installations.

**UNIT-V:**

Position restricted: Jib cranes and other fixed industrial robots.  
Auxiliary equipment: Load carriers (Pallets, Stillage etc.)  
warehouse layouts, goods reception and dispatch equipment,  
equipment for assembling and securing loads.

**Books and References:**

1. Material Handling System Design      James Apple
  2. Hand Book of Industrial Engg.      G. Saliendy
  3. Facilities Planning                      James Tomphines & John
  4. Industrial Engg.                          John M. Hill
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**ELECTIVE – I    COMPUTER AIDED    MACHINE    DESIGN**  
**M 412**

**UNIT I :**

Introduction to computer technology, computer systems, operating the computer system, hardware in computer aided design. Mechanical design process, benefits of computer aided design, role of design analysis programs in CAD.

**UNIT II :**

Principles of interactive computer graphics, geometric modeling, modeling and display of curves and surfaces, introduction and application of a graphic software (e.g. Auto CAD).

**UNIT III :**

Computer aided design and drafting data base facility, part library, standard component and symbol library creation and operation, associability between master entities and occupancies, attribute definition and generation of bill of materials, database management.

**UNIT IV :**

Introduction to optimal design and optimization techniques for design of mechanical elements, computer aided optimum machine elements such as springs, shafts, bearings gears, etc.

**Books and References:**

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|----|-----------------------|-------------|
| 1. | Computer Aided Design | Taylor      |
| 2. | Computer Aided Design | Sadhu Singh |
| 3. | Computer Aided Design | Zoomer      |

**ELECTIVE – I SOLAR ENERGY - THEORY AND  
APPLICATIONS  
M 413**

**UNIT I :**

Solar energy perspectives and prospects.

Solar system - solar radiation - solar constant - isolation on the surface of earth measurement data and estimation.

**UNIT II :**

Utilization of solar energy, potential uses of solar energy, technical and economic viability, low and high temperature solar energy devices.

**UNIT III :**

Solar Collectors: Flat plate type:

Flat plate collectors-characteristics of flat plate collectors, loss coefficient and heat transfer to the flowing medium.

Flat plate collectors: design and performance of solar water heaters- optimization of tilt.

**UNIT IV :**

Solar Collectors: Focussing type:

Various type of focusing collectors, materials and performance characteristics.

Design of focussing collectors, Energystorage-need for storage - thermal and physico chemical storage - solar ponds.

**UNIT V :**

Applications:

- A. Solar air heaters-design, analysis and performance
- B. Solar refrigeration - Ammonia water and ammonia sodium thiocynate systems food preservation.
- C. Space heating/cooling, solar heating systems-solar cooling systems.
- D. Solar drying-agriculture and industrial drying, cabinet type dryer-general considerations.
- E. Solar stills-portable and large units, theoretical consideration performance.
- F. Use of solar energy in bio-gas production
- G. Photovoltaic conversion
- H. Solar power generation - system analysis, design and economic considerations.

**Books and References:**

- 1. Solar Engg. Thermal Proccession Buffa & Buckman
- 2. Solar Energy G.D. Rai
- 3. Engg. Technology S. Rao & D.B Parulkar
- 4. Solar Energy Sukhat me

**ELECTIVE – I    Finite Element Method  
M414**

**Unit – I : Basics of Fem:**

Analytical, Experimental and Numerical methods of analysis. Finite difference and Finite Element Method. Various approaches used in FEM. Steps in : Finite Element Method. Direct Stiffness Method. Application to spring problems .

**Unit – II :**

Energy approach. Detailed method of analysis. Applications to one dimensional bar, beam and shafts problems. Analysis of plane trusses.

**Unit – III :**

Applications of FEM to two dimensional problems. Triangular element. Applications to vibration problems.

**Unit – IV :**

Galerkin's method. Its applications to one dimensional fluid flow problems.

**Unit – V :**

Use of Softwares such as ANSYS/NASTRAN/IDEAS. Basic feature of these softwares.

Solution techniques used in FEA. Various types of elements .

Introduction to isoparametric elements.

**Books and References:**

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|----------------------------|-------------------------------|
| 1. Finite Element Method   | O.C. Zienkiewicz & R.A.Taylor |
| 2. Finite Element Analysis | C.S. Krishnamurthy            |
| 3. Finite Element Method   | Kenneth H. Hubener            |

#### **UNIT-I**

Training for Safety: Industrial training, training in workshop and laboratories, schools, colleges and universities, communicating the safety message.

#### **UNIT-II**

Safe Practices in Industry and Chemical Handling: Commercial vehicles, compressed air, entry into confined spaces, fire control manual, automatic, static electricity, grinding operations, ionizing, radiation, mechanical safety and electrical control, gear manual handling, mechanical handling, running pipes, steam boilers and pressure vessels welding operations.

#### **UNIT-III**

Provisions for safe working: Commercial occupations, construction industry, port transport industry, getting standards for safe equipment, working with machinery. Creating a safe environment, ergonomics as an aid to safety. Lighting for safety. Noise control. Safety colors, signs and codes.

#### **UNIT-IV**

Personal Protection and welfare: Medical services, first aid and causality treatment, eye protection, personal equipment and protection, respiratory equipment, skin care.

#### **UNIT-V**

Some view on Safety: The role of factory inspectorate, safety organization in the works, trade unions and safety, legal aspects of industrial safety, the cost of industrial injuries.

#### **Books and References:**

1. Safety Management John V. Grimaldi & Rollin H.
  2. Industrial Safety Hand Book William Hand ley (Mc. Graw Hill)
  3. Safety Security & Risk Management V.K. Singh (AIPH)
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**ELECTIVE - II ENERGY CONSERVATION**  
**M 421**

**UNIT I :**

Introduction: Energy and development role of energy in industrial activity. Contemporary energy crisis, conventional and non conventional energy sources, energy demand and availability. Energy audit need for energy conservation. Energy conservation techniques in domestic, transport and in industrial sector, energy conservation in buildings.

Energy Conservation in production of heat: Fuel consumption economy, firing arrangement and selection of burners. Fluidised bed combustion.

**UNIT II :**

Energy conservation in use of heat. Economical design of furnace, water treatment, drying, conditioning and industrial space heating, boiler accessories etc.

Heat recovery in waste heat boilers: Conservation, integrated energy systems for industries.

**UNIT III :**

Selection of cycles: Combined cycle, power generation for better energy efficiency management. Arrangement of combined cycle. Different systems for combined cycle power generation. Advantages of combined cycle power plant. Energy conservation furnish better management techniques, improved production design, improved production powers, substituted materials, waste recovery and recycling.

**UNIT IV :**

New and renewable energy technologies: New coal techniques justification and liquification of coal, diesel - energy conversion systems-magneto hydro dynamics, electro gas dynamic, thermoionic, thermoelectric generators, fuel cells, hydrogen economy, renewable energy sources, solar, wind, hydro, biomass, tidal, geothermal, animal and human energy. Appropriate energy technology for rural development. Energy conservation in production, agriculture sector.

**UNIT V :**

Instrumentation and control in energy conservation. Economics of conventional and new and renewable energy technologies.

Environmental aspects and case studies : Environmental control, health and safety on the plant, energy conservation in Indian industries - case study.

**Books and References:**

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|----------------------------|-----------------------|
| 1. Power plant Engineering | Domkundwar            |
| 2. Power plant Engineering | G.D. Rai              |
| 3. Power plant Engineering | R.L. Agrawal          |
| 4. Energy Technology       | S. Rao & B.B. Parulka |

**ELECTIVE – II INDUSTRIAL TRIBOLOGY**  
**M 422**

**UNIT-I:**

Introduction: Surface interactions, science of rubbing surface, general consideration of parameters involved, wear rate, modelling and solution of simple problems.

**UNIT-II:**

Material properties influencing interactions: Introduction, elastic properties, plastic deformation properties, relation between the strength and other properties of solids, chemical reactivity of surfaces, absorbed surface layer, surface energy, relation between surface energy and hardness, surface interfacial energies of solids under engineering condition.

**UNIT-III:**

Surface Interaction:, Size of real contact area and effect of surface energy, size of junction, rheological properties.

Wear in tribological joints - classification, calculation methods with allowance for stiffness, wear limits, reliability of joints, simple examples, detail study of manufacturing methods for highly reliable joints. Economic role of wear, measurement, types, and use of radiotracer techniques.

**UNIT-IV:**

Adhesive wear: Mechanism, size, shapes of transferred and wear particles, quantitative laws, equilibrium calculation of fragments under different conditions, minimum load for loose particle formation.

Quantitative expression for abrasive wear, of hardness and particle size on abrasive wear rate, surface fatigue wear, brittle fracture wear, corrosive wear with types.

Friction: Introduction, laws, function, properties of uncontaminated metals in air, outgassed metal surface, calculation of flash temperature using surface energy, stic-slip and its prevention.

**UNIT-V:**

Lubrication: Solid film lubrication, boundary lubrication with single and multiple penetration model, properties of lubricants, effectiveness of lubrication-intermediate temperature, behaviour of a solid lubrication below melting point effect of speed, load on lubrication. Lubrication their properties lubrication technique in vacuum, lubricant coating and its stability. Theory of elastohydrodynamic lubrication film thickness, frictional stress heat flow & temperature, service life of roller bearings.

**Books and References:**

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|-----------------------------------|--------------|
| 1. Basic Lubrication Theory       | A. Cameron   |
| 2. Friction and wear of Materials | E. Rabinwicz |
| 3. Maintenance Engg. Hand Book    | L. Higgens   |

**ELECTIVE – II    ADVANCED ENGINEERING MATHEMATICS  
M 423**

**UNIT I :**

Fourier Series: The orthogonal set of function, orthogonality of Bessel's function and Legendre's polynomials, Sturm and Liouville's problem. Fourier integral, solution of boundary value problem by the use of Fourier series and Fourier integral.

**UNIT II :**

Integral Transform: Laplace Transform. Transform of Fourier, Hankel and Mellin inversion and convolution theorem, Application of Hankel and Mellin transforms in solving ordinary differential equations and that of Fourier transform in solving partial differential equations including the equations of steady flow.

**UNIT III :**

Tensors: Definition of covariant, contravariant and mixed tensor, tensor algebra, matrix tensors, Christoffel's symbol, covariant differentiation, gradient, divergence, Curl and Laplace operation in tensor notation.

**UNIT IV :**

Complex Variable: Applications of analytic function in two dimensional problems, conformal transformations with application in electrostatic and electrodynamics.

**UNIT V :**

Matrices: Inverse, Linear transformations, linear quadratic forms, Cayley-Hamilton theorem, minimal equations, eigenvalues, rank, triangularisation and diagonalisation of matrices.

**Books and References:**

1. Higher Engg. Mathematics                      B.S. Grewal
2. A Text Book of Engg. Mathematics        Srivastava and Dhawan
3. Engg. Mathematics                                S. S. Sastry

**ELECTIVE – II    INDUSTRIAL MEASUREMENT & QUALITY  
CONTROL  
M 424**

## **UNIT-I**

Stress-strain measurement and strain gauges: Introduction, mechanical strain gauge, optical strain gauge, stress measurement by photo elastic, instruction for strain gauge stress-strain relationship.

## **UNIT-II**

Measurement of vibration: Common causes of vibration, diagnosis and remedial measurement methods for vibration measurements, vibrations, vibration amplifier for permanent monitoring.

## **UNIT-III**

Speed measurement: Mechanical tachometer, electric tachometer, different types of tachometer, pneumatic types speed transmitting elements.

Temperature Measurement: Technical temperature measurement, method for measuring temperature, radiation properties, optical properties, electrical properties, thermocouples, thermistors.

## **UNIT-IV**

Analysis: Spectroscopic analysis, absorption spectrometer, gas analysis, chromatography, infrared gas analyser.

Level Measurement: Direct and indirect methods, electrical conductivity method, robotics method, solid level detector, level measurement by capacitance probes.

## **UNIT-V**

Fundamentals of industrial measurement: Basic principles of measurement, basic characteristics and dynamics of measuring instruments.

Transducers and sensing elements: Classification capability of transducers, digital transducer, hydro pneumatic sensor, thickness sensor, mechano-electrical transformation.

## **Books and References:**

1. Industrial Instrumentation D.P. Eckman
  2. Mechanical Measurements Backwith and Buck
  3. Instrumentation Measurements and Analysis Nakre & Chaudhary
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**ELECTIVE – II ADVANCED STRENGTH OF MATERIALS**  
**M 425**

**UNIT I:**

Theory of Elasticity: Plane stress and plane strain problem, strain-displacement relation, stress - strain relations, equilibrium equations, body force, compatibility equations, airy stress function, analysis of simple two dimensional problems in Cartesian coordinates.

**UNIT II:**

Plates: Bending of circular plates carrying uniformly distributed load over entire surface or with concentrated load at centre, simply supported rectangular plate carrying uniformly distributed (excluding derivation of formulae).

**UNIT III:**

Torsion of non-circular section shafts: St. Venant's methods, torsion of shafts of elliptical and rectangular sections, membrane analogy, torsion of shafts of thin tubular section.

Laterally loaded columns: Analysis of long columns carrying lateral loads in addition to axial compression eccentrically loaded columns.

Beams on Elastic Foundations: Modules of foundation, equation of elastic curve, solution for beams of infinite and semi infinite length.

**UNIT IV:**

Deformation beyond elastic limit: Behaviour of material beyond elastic limit, perfectly plastic material, torsion of shafts and analysis of thick cylinders with radial pressure when loaded beyond elastic limit, residual stresses.

Mechanics of forming processes: Mechanics of wire drawing and tube drawing through cylindrical and conical dies, calculation of draw forces, effect of back pull, mechanics of forging process.

**UNIT V:**

Miscellaneous Topics: Contact stress in ball and roller bearings, bending of curved tubes, stress analysis of flywheel.

Design of members for fatigue and creep: Fatigue behaviour, factors affecting fatigue, mechanics of fatigue failure, fatigue under combined stresses, fatigue life and cumulative fatigue, design formulae for fatigue calculations.

Mechanics of creep, relationships regarding creep rates at different stresses and temperature, bending of beams at high temperature, stress relaxation in steam turbine bolting, creep under combined stresses, creep analysis of rotating discs.

**Books and References:**

1. Mechanics of Materials Vol. II E.J. Hearn
2. Strength of Materials Vol II Timoshenko

**REFRIGERATION AND AIR CONDITIONING LAB.**  
**M444**

<b>S. No.</b>	<b>Name of Experiment</b>
1.	One Ton Ice Manufacturing Plant.
2.	Performance Testing of Central Air Conditioning System.
3.	Determination of COP of One Ton Cold Storage Plant.
4.	To Study Hermetically Sealed Compressor For Vcrs.
5.	Performance Testing of a Vapour Compression Refrigerator System.
6.	Performance Testing of a 35 Ltr. Drinking Water Cooler.
7.	To Study the Different Control System for Vapour.
8.	Performance Testing of a 1.5 Tr Window Air Conditioning System.
9.	Performance Analysis of the Solar Vapour Absorption Refrigeration System.
10.	Performance Analysis of a Domestic Evaporative Cooler.

**PRODUCTION & INDUSTRIAL ENGINEERING LAB.**  
**M 442**

<b>S.No.</b>	<b>Name of Experiment</b>
1.	Design of Drilling Jig.
2.	Design of a Milling Fixture.
3.	Rigidity Test of Lathe Machine.
4.	Part Programming on CNC Lathe/ Milling.
5.	Preparation of Tool Layout on Capstan/Turret Lathe.
6.	Types of Chips under different cutting conditions.
7.	Study of oil hydraulic power press system.
8.	Peg board experiment.
9.	Determination of rating factor.
10.	Preparation of control charts for variables.
11.	Control charts for attributes.
12.	Time study using stop watch on a lathe / drilling machine.
13.	Time study using PMTS.

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**MAJOR PROJECT & SEMINAR**

**M 448**

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**EDUCATION TOUR & TRAINING**

**M 449**

6 week training to be undertake in relevant industry suggested by the  
DEPARTMENT of MECHANICAL ENGINEERING.

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