C24-CURRICULUM

DIPLOMA IN

MECHANICAL ENGINEERING

Offered By

STATE BOARD OF

TECHNICAL EDUCATION AND TRAINING TELANGANA HYDERABAD

V SEMESTER

S. NO	Course		Teaching Scheme					Examination Scheme						
			Instruction Periods per week			Total Periods per semester	Credits	Continuous Internal Evaluation (CIE)			Semester End Examination (SEE)			
	Code	Course Name	L	T	P			Mid Sem 1	Mid Sem 2	Internal Evaluation	Max marks	Min marks	Total Marks	Min marks for passing including internal
1	ME-501	IME & Start Ups	4	1	0	75	2.5	20	20	20	40	14	100	End Marks shall be ≥35% of Topper Marks and Subject Total Shall be ≥ D-Hybrid Grade Minimum
2	ME-502	Refrigeration and Air Conditioning	4	1	0	75	2.5	20	20	20	40	14	100	
3	ME-503	computer aided design and manufacturing	4	1	0	75	2.5	20	20	20	40	14	100	
4	ME-504	Fluid Power Systems	4	1	0	75	2.5	20	20	20	40	14	100	
5	AU-515A	Automobile Engineering	4	1	0	75	2.5	20	20	20	40	14	100	
	EE-505B	Electric Vehicles												
6	ME-506A	Introduction to Artificial Intelligence	4	1	0	75	2.5	20	20	20	40	14	100	
	ME-506B	Mechatronics												
7	ME-507	Manufacturing Automation Lab	1	0	2	45	1.25	20	20	20	40	20	100	End Marks shall be ≥50% of Topper Marks and Subject Total Shall be ≥ D-Hybrid Grade Minimum
8	ME-508	Metrology lab and Pneumatics Lab	1	0	2	45	1.25	20	20	20	40	20	100	
9	ME-509	Refrigeration and Air Conditioning Lab	1	0	2	45	1.25	20	20	20	40	20	100	
10	ME-510	Project work	1	0	2	45	1.25	20	20	20	40	20	100	
			28	6	8	630	20	200	200	200	400	164	1000	

ME-501 – IME & STARTUPS

Course title	IME & Startups	Course code	ME-501
Semester	V	Course group	Core
Teaching scheme in periods (L:T:P)	4:1:0	Credits	2.5
Methodology	Lecture+ Tutorial	Total Contact Periods	75
CIE	60 Marks	SEE	40 Marks

Prerequisites: Knowledge of Basic Sciences.

COURSE OUTCOMES

On successful completion of the course, the students will be able to

Course Outcomes	
CO1	Illustrate the principles and functions of management and Outline Organization structure&Organizational behaviour
CO2	Summarise the Functions of Production Management
CO3	Analyse the functions of Materials Management
CO4	Compare Marketing, sales & Feasibility study
CO5	State the use of ISO 9000 & T.Q.M and discussIndustrial legislation & safety
CO6	Illustrate Entrepreneurship and Start-ups

Blue Print of Marks for SEE:

<table>
<tr><th colspan="2" rowspan="2">Units</th><th rowspan="2">No of periods</th><th colspan="4">Questions to be set for SEE</th><th rowspan="2">Remarks</th></tr>
<tr><th colspan="2">R</th><th>U</th><th>A</th></tr>
<tr><td rowspan="2">Part-A</td><td>I. Management,Organisation structure and behaviour</td><td>13</td><td rowspan="6">Q4</td><td colspan="2" rowspan="2">Q1</td><td rowspan="2">Q9(a)</td><td rowspan="2">Q13(a)</td><td></td></tr>
<tr><td>II.Production management</td><td>12</td><td></td></tr>
<tr><td rowspan="2">Part-B</td><td>III.Materials management</td><td>12</td><td colspan="2" rowspan="2">Q2</td><td rowspan="2">Q10(a)</td><td rowspan="2">Q14(a)</td><td></td></tr>
<tr><td>IV.Marketing, Sales & feasibility study</td><td>13</td><td></td></tr>
<tr><td rowspan="2">Part-C</td><td>V. Quality & ISO 9000 and Industrial Legislation & safety</td><td>13</td><td rowspan="2">Q3</td><td>Q5
Q6</td><td>Q9(b)
Q11(a)
Q11(b)</td><td>Q13(b)
Q15(a)
Q15(b)</td><td></td></tr>
<tr><td>VI.Entrepreneurship and start-ups</td><td>12</td><td>Q7
Q8</td><td>Q10(b)
Q12(a)
Q12(b)</td><td>Q14(b)
Q16(a)
Q16(b)</td><td></td></tr>
<tr><td colspan="2">TOTAL</td><td>75</td><td colspan="2">08</td><td>08</td><td>08</td><td></td></tr>
</table>

COURSE CONTENT

UNIT-I: Management, OrganizationStructure and Behaviour

Duration: 13 Periods (L: 11.0 – T: 2.0)

Management-Concept, Evolution, Levels, Skills and Functions, Principles of Scientific Management, Management Information System (MIS)-Concept and Models, Organisation and Organisation Structure Meaning, Types of Ownerships-Sole Proprietorship, Partnership,Joint Stock Companies, Co-operative Societies and Public Organisations, Line and Staff and Functional Organisations, Concept of OrganisationBehaviour,Job analysis,Motivation- Theories of Motivation, Leadership-Styles

UNIT-II

Production Management **Duration: 12 Periods (L: 10.0 – T: 2.0)**

Production Management, Relation of Production department with other departments, Production, Planning and Control (PPC)-Meaning, Functions of PPC – Planning, Routing, Scheduling, Dispatching and Follow up (Expediting)-Need, Procedure, PERT and CPM - Concept, Simple problems.

UNIT-III

Materials Management **Duration: 13 Periods (L: 11.0 – T: 2.0)**

Role of Materials in industry, Materials Management - Objectives and Functions, Inventory Control models- ABC Analysis, Re-order level, Economic Order Quantity(EOQ) and Automated inventory management system (IMS), Stores-Layout and Equipment, Stores Records-Bincard and Cardex method, Purchasing- Procedure, Records

UNIT-IV

Marketing, Sales &Feasibility study **Duration: 12 Periods (L: 10.0 – T: 2.0)**

Sellers and Buyers market, Marketing, Sales, Market conditions, Oligopoly, Perfect competition, Cost -Elements of Cost, Break-even analysis, Market Survey, Product and Production Analysis, Materials Input, Manpower, Location, Economic and Technical Evaluation, Preparation of Feasibility Study report.

UNIT-V

Quality & ISO 9000and Industrial Legislation &Safety

Duration: 13 Periods (L: 11.0 – T: 2.0)

Concepts of Quality, Quality Control, Quality Assurance and Quality Systems-Elements, ISO 9000 series-Features, Advantages, Limitations and Beneficiaries.TQM, Concept of zero defects**, 5-S**Principles, Lean Management, Kaizen and Poka Yoke Concept.Employer-employee relations-rights and responsibilities, Trade Unions, Causes and Settlement of disputesmethods, Indian Factories Act-Salient features, Safety at workplaces-Importance, Hazards-Types and Accidents.

UNIT-VI

Entrepreneurship and Start-ups **Duration: 12 Periods (L: 10.0 – T: 2.0)**

Entrepreneur, Entrepreneurship, Intrapreneurship,Self–employment schemes, Institutional support needed, financial assistance programs. Start-ups– Features, Benefits, Schemes, Need of Start-Ups in 21stCentury-Gaps to Start Start-Ups -Features and Start-Upsregistration process, List of successful Start-Ups.

REFERENCE BOOKS

1. Industrial engineering and management by O.P Khanna.
2. Production management by Buffa
3. Industrial Engineering & Management Science by TR Banga
4. Engineering Economics and Management Science by Banga & Sharma
5. Personnel management by Flippo
6. Lean management tools and techniques by Sateesh Raju G
7. Entrepreneurship by NITTTR Chennai.

ELECTRONIC RESOURCES

1. https://nptel.ac.in/courses/
2. https://www.slideshare.net/
3. https://en.wikipedia.org/wiki/
4. http://ndl.ethernet.edu.et/bitstream/
5. https://webapps.ilo.org/

SUGGESTED STUDENT ACTIVITIES

1. Identify any 5 industries with different types of ownership.
2. Prepare an organizational structure forthe institution
3. Survey Product marketing.
4. Prepare a list of ISO 9000 series as well as latest quality standards
5. Prepare sign boards representing safety measures.
6. Role-play as an entrepreneur
7. Ccase study on a Start-up

SUGGESTED LEARNING OUTCOMES

Upon completion of the course the student shall be able to

CO1: Illustrate principles and functions of management and Outline Organization structure& organizational behavior

1.1 Define Management and Administration
1.2 Discuss the evolution of Management
1.3 Discuss Levels and Skills of Management
1.4 Illustrate functions of Management
1.5 Explain the Principles of Scientific Management
1.6 Define Management Information System (MIS).
1.7 Discuss the importance of MIS
1.8 Illustrate the models of MIS
1.9 Define Organisation and Organisation Structure
1.10 Explain different types of Ownerships-Sole Proprietorship, Partnership, Joint Stock Company, Co-operative Societies and Public Sector Organisations
1.11 Explain Line, Staff and Functional Organisations
1.12 Understand Organisation behaviour
1.13 Explain Job analysis
1.14 List and Explain Motivation theories
1.15 Explain the Line, Staff and Functional organisations.
1.16 Explain different leadership styles.

CO2: Summarise the Functions of Production Management

2.1 Define Production, Planning and Control.
2.2 Relate the production department with other departments.
2.3 Discuss the functions of Production, Planning and Control.
2.4 State the Need for Planning
2.5 Explain the Routing procedure.
2.6 Explain Scheduling Methods.
2.7 Explain the Dispatching procedure
2.8 Explain Expediting (Follow up)
2.9 Draw PERT/CPM networks.
2.10 Identify the critical path
2.11 Problems on PERT & CPM.

CO3: Analyze the functions of Materials Management

3.1 State the role of materials in the Industry
3.2 Discuss the Objectives and Functions of Materials management
3.3 Define Inventory and Inventory ControlDe
3.4 Explain ABC analysis.
3.5 Define Reorder level
3.6 Derive the expression of EOQ for inventory control.
3.7 Define safety stock, Buffer stock
3.8 Discuss Automated Inventory Management System (IMS)
3.9 State the Functions of the Stores department
3.10 Explain the Stores layout,
3.11 Discuss the Stores Equipment
3.12 Explain the Store records.
3.13 Discuss the Bincard and Cardex method.
3.14 List Objectives and functions of the Purchasing department
3.15 Explain Purchasing procedures.
3.16 List out Purchase records.

CO4: Compare Marketing, Sales & Feasibility study.

4.1 Define Marketing and Sales
4.2 Differentiate Sellers and Buyer'sMarket
4.3 Discuss Marketing and Sales functions.
4.4 List out Marketing conditions.
4.5 Differentiate Monopoly, Oligopoly and Perfect Competition.
4.6 Define Cost and list the Elements of Cost
4.7 Explain Break-even analysis
4.8 Steps in conducting Market and Demand surveys.
4.9 Differentiate Product and Production Analysis.
4.10 Identify the input materials, i.e. Bill of materials

4.11 Discuss the factors to choose Plant Location
4.12 Evaluate Economic and Technical factors.
4.13 Discuss the Preparation of the Feasibility Study.

CO5: State the use of ISO 9000 & TQM and discuss Industrial legislation & safety

5.1 Define Quality, Quality Control, Quality Assurance and Quality System
5.2 Discuss the Elements of Quality Systems.
5.3 Discuss ISO 9000 series of Standards.
5.4 State Advantages, Limitations and Beneficiariesof ISO 9000 series
5.5 Explain the Concept of TQM
5.6 Define Lean management,Kaizen and Poka-Yoke concepts
5.7 Define the term "ZERO DEFECT"
5.8 State 5-S principles.
5.9 Discuss the Employer and Employee relations
5.10 List out the rights and responsibilities of employees and employers.
5.11 Define Trade union and list its functions
5.12 Explain the Causes and settlements of Industrial disputes.
5.13 List the salient features of the Indian Factories Act.
5.14 Explain the importance of safety and its provisions at workplaces
5.15 Discuss types of hazards and their causes

CO6: Illustrate Entrepreneurship and Start-ups

6.1 Define Entrepreneur, Intrapreneur and Entrepreneurship
6.2 Discuss the qualities of an entrepreneur.
6.3 Explain the role of entrepreneurs in promoting Small Scale Industries.
6.4 Explain different Self-employment schemes.
6.5 Discuss Institutional and Financial Assistance ProgramInstitutions
6.6 Define Start-ups
6.7 State the Needfor Start-ups in the 21stCentury
6.8 Explain the features and registration processfor Start-ups
6.9 List various Start-up schemes and their benefits
6.10 Identify the gaps for initiating Start-ups.
6.11 List out the most successful recent start-ups in India.

COURSE OUTCOMES		CL	Linked POs	Teaching Periods
CO1	Illustrate the principles and functions of management and Outline Organization structure& organizational behavior	R, U, A	5,6,7	13
CO2	Understand the Functions of Production Management	R, U, A	2,5,6	12
CO3	Analyse the functions of Materials Management.	U, A	1,6,7	12
CO4	Compare Marketing, sales & Feasibility study.	U, A	1,6,7,	13
CO5	State the use of ISO 9000 & T.Q.M and discussIndustrial legislation & safety	U, A	1,6,7	13
CO6	Illustrate Entrepreneurship and Start-ups	R, U, A	1,6,7	12
			Total Periods	**75**

Legends: R = Remember; U= Understand; A= Apply and above levels (Bloom's revised taxonomy)

CO-PO Attainment Matrix:

COURSE OUTCOMES	PROGRAM OUTCOMES						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1					2	3	1
CO2		2			1	3	
CO3	1					2	3
CO4	1					3	2
CO5	2					3	1
CO6	1					2	3

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Lowly Addressed**.**

STATE BOARD OF TECHNICAL EDUCATION & TELANGANA
MID SEM-I Model Paper
ME-501 - IME & START UPS

Time: 1 hr **Max. Marks:20**

PART-A **4x1=4Marks**

NOTE: 1) Answer all questions and each carries **one** mark.
2) Answers should be brief and straight to the point and shall not be exceed three simple sentences.

1. Who makes policies of an organisation?
2. Define management information system(MIS)
3. What do you understand about routing?
4. What does CPM Stands for.?

PART-B **2X3M=6 Marks**

NOTE: 1) Answer all questions and each carries **three** marks.
2) Answers should be comprehensive and the criterion for valuation is the content but not length of the answer.

5.(a) What type of managerial skills required by top level management

OR

5.(b) List out theories of motivation.

6.(a) Which type of projects uses PERT network technique and why?

OR

6.(b) Discuss about scheduling

PART-C **2X5M=10 Marks**

NOTE: 1) Answer all questions and each carries **five** mark.
2) Answers should be comprehensive and the criterion for valuation is the content but not length of the answer.

7.(a) Explain the principles of scientific management

OR

7.(b) Explain about Maslow's theory of motivation

8.(a) Draw the project network of the given project and identify all paths through it. Find the critical path, TL and T_E on the network.

Activity	Optimistic Time(a)	Most likely Time (m)	Pessimistic Time (b)
1-2	1	1	7
1-3	1	4	7
1-4	2	2	8
2-5	1	1	1
3-5	2	5	14
4-5	2	6	10
5-6	3	6	15

OR

8.(b) Which leadership style gives more freedom at work place?And discuss about it

STATE BOARD OF TECHNICAL EDUCATION & TELANGANA
MID SEM-II , Model Paper
ME-501 IME & START UPS

Time: 1 hr Max. Marks:20

PART-A **4x1=4Marks**

NOTE: 1) Answer all questions and each carries **one** mark.
2) Answers should be brief and straight to the point and shall not be exceed three simple sentences.

1. Ajay purchased more material with less cost. which class material in ABC analysis?
2. When do we use buffer stock?
3. What Is a feasibility study?
4. What is Breakeven Point?

PART-B **2X3M=6 Marks**

NOTE: 1) Answer all questions and each carries **three** mark.
2) Answers should be comprehensive and the criterion for valuation is the content but not length of the answer.

5.(a) List the advantages of ABC analysis.

OR

5.(b) State the functions of Material Management.

6.(a) List out the elements of cost ?

OR

6.(b) What is buyer's market and seller's market.

PART-C **2X5M=10 Marks**

NOTE: 1) Answer all questions and each carries **five** mark.
2) Answers should be comprehensive and the criterion for valuation is the content but not length of the answer.

7.(a) Explain the functions of Purchase management.

OR

7.(b) Explain various records used in stores.

.

8.(a) What is Break-even analysis? Illustrate graphically the concept of Break-even point.

OR

8.(b) Differentiate Product and Product analysis.

STATE BOARD OF TECHNICAL EDUCATION & TELANGANA
BOARD DIPLOMA EXAMINATION, (C-24)
SEE-MODEL PAPER ME-501
DME– V SEMESTER EXAMINATION
ME-501 –IME & START UPS

Time: 2 Hours **Max. Marks:** 40

PART-A 8 X 1 = 8

Instructions: 1. Answer **ALL** questions.
2. Each question carries **ONE** mark.

1. What do you say about Organisation behaviour?
2. Where you can usea bin card?
3. List two benefits of ISO 9000 certification.
4. Define PERT.
5. Define Quality control.
6. What is ISO.
7. Why trade unions formed?
8. Name any two entrepreneurs in India.

PART-B 4 X 3 = 12

Instructions: 1. Answer **ALL** questions.
2. Each question carries **THREE** marks.

9. (a) Differentiate Line Organisation and Line and Staff Organisation.

OR

9. (b)What are the 5-S principles?
10. (a) What do you understand about inventory control?

OR

10. (b) How an Entrepreneur helps in economic development
11. (a) List the beneficiaries of the ISO 9000 certificate.

OR

11. (b)Explain about quality assurance.
12. (a) What do you understand expectations of an entrepreneur

OR

12. (b) Name any six startups recently in India.

PART-C 4 X 5 = 20

Instructions: 1. Answer **ALL** questions.
2. Each question carries **FIVE** marks.

13. (a) Explain the principles of Scientific management stated by F.W. Taylor

OR

13(b) Explain various elements of quality systems.

14 (a) Ramesh started a company. he wants to purchase materials on cost analysis. What Typeof inventory control technique select and explain about it?

OR

14(b) Explain the factors influencing the site selection for a plant location.

15 (a) What are the different ISO-9000 series. Explain about them.

OR

15(b) Explain the rights and responsibilities of the Employee and Employer.

16(a) Explain the role of an entrepreneur in the promotion of small-scale industries

OR

16(b) Explain various steps to start Start-ups.

ME 502 – REFRIGERATION AND AIR CONDITIONING

Course Title:	Refrigeration and Air Conditioning	Course Code:	ME-502
Semester:	V	Course group :	Core
Teaching Scheme(L:T:P):	4:1:0	Credits:	2.5
Methodolgy :	Lecture + Assignment	Total contact periods:	75
CIE:	60 Marks	SEE:	40 Marks

Pre-requisites: Basic knowledge of Thermodynamics.

COURSE OUTCOMES

	On Successful completion of the course, the student will be able to
CO 1	Classify and explain the methods of refrigeration and elaborate air refrigeration cycles
CO 2	Evaluate vapour compression and vapour absorption refrigeration systems, calculate parameters and compare the systems
CO 3	Adapt to eco friendly refrigerants and know the function of equipment used in refrigeration, describe and differentiate them.
CO 4	Outline and determine various psychrometric properties, Analyze psychrometric processes..
CO 5	Explain and Assess working of various air conditioning equipment and draw their layout
CO 6	Make use of recent trends in the field of refrigeration and air conditioning and correlate them with their application in industry

COURSE CONTENT AND BLUE PRINT OF MARKS FOR SEE

<table>
<tr><th rowspan="2">Unit No</th><th rowspan="2">Unit Name</th><th rowspan="2">Periods</th><th colspan="3">Questions to be set for SEE (Q No)</th><th rowspan="2">Remarks</th></tr>
<tr><th colspan="2">R</th><th>U</th><th>A</th></tr>
<tr><td>1</td><td>Introduction to Refrigeration & Air refrigeration systems</td><td>12</td><td rowspan="6">4</td><td rowspan="2">1</td><td rowspan="2">9(a)</td><td rowspan="2">13(a)</td><td></td></tr>
<tr><td>2</td><td>Vapour compression and absorption refrigeration Systems</td><td>13</td><td></td></tr>
<tr><td>3</td><td>Refrigerants and refrigeration equipment</td><td>13</td><td rowspan="2">2</td><td rowspan="2">10 (a)</td><td rowspan="2">14 (a)</td><td></td></tr>
<tr><td>4</td><td>Psychrometry& Psychrometric processes</td><td>12</td><td></td></tr>
<tr><td>5</td><td>Air distribution and Air conditioning equipment</td><td>12</td><td rowspan="2">3</td><td>5, 6</td><td>9(b), 11(a), 11(b)</td><td>13(b), 15(a), 15(b)</td><td></td></tr>
<tr><td>6</td><td>Applications of refrigeration and air conditioning – Recent trends in Refrigeration and air conditioning.</td><td>13</td><td>7, 8</td><td>10(b), 12(a), 12(b)</td><td>14(b), 16(a), 16(b)</td><td></td></tr>
</table>

Legend: R:Remembering, U: Understanding A: Applying

COURSE CONTENT

Refrigeration and Air conditioning

Unit – 1 Introduction to Refrigeration & Air refrigeration systems

Duration: 12 Periods (L: 10 – T:2)

Definition of refrigeration, Air conditioning – Heat engine, refrigerator and heat pump. Basic terms involved in refrigeration : Refrigeration effect, Work of compression, COP, Ton of refrigeration, Power required per TR – Natural and Artificial methods of refrigeration : Ice, Dry Ice refrigeration. — Thermodynamic analysis of Reversed Carnot refrigeration cycle – Limitations - Thermodynamic analysis of Bell Coleman refrigeration cycle .

Unit – 2 Vapour compression and absorption refrigeration Systems

Duration: 13 Periods (L: 10 – T: 3)

Vapour compression refrigeration system (VCRS):-Principle –Thermodynamic analysis of VCRS -Factors effecting performance of VCRS - Wet and dry compression –Receiver, Accumulator, strainer , drier and flash chamber.

Vapour absorption refrigeration system(VARS):-Principle – Refrigerant absorbent pairs - Working of Ammonia water vapour absorption refrigeration system – Working of Lithium Bromide Water vapor absorption refrigeration system- Expression for COP of VARS.

Unit – 3 Refrigerants and refrigeration equipment

Duration: 13 Periods (L:10 – T:3)

Refrigerants:- Definition - Primary and secondary refrigerants -– properties of good refrigerants – Commonly used refrigerants – Ozone depletion, phase out of Chlorofluro carbon refrigerants – Montreal protocol – Global warming and Kyoto protocol.

Refrigeration equipment :-Hermetic compressor – Natural circulation tube and fin air cooled condenser, forced circulation tube and fin air cooled condenser, shell & tube water cooled condensers and evaporative condenser –Capillary tube and thermostatic expansion valve – Difference between direct evaporator and flooded evaporator, and Plate surface evaporator, Bare tube evaporator, finned tube forced circulation evaporator and Shell and tube evaporator , ,.

Unit – 4 Psychrometry& Psychrometric processes

Duration: 12 Periods (L: 10 – T:2)

Definition of air conditioning - Classification of air conditioning systems - Human comfort conditions – Effective temperature – Factors governing effective temperature – comfort chart. Psychrometry:-Definition– Psychrometric terms – Carrier Equation - Psychrometric chart – Psychrometric processes

Unit – 5 Air distribution and Air conditioning equipment

Duration: 12 Periods (L: 10 – T:2)

General Air distribution (Air flow diagram for an ac system) – Air distribution system in a Room :- Ejection system, Downward system and Upward system. -Ducts: -Definition, Types, material used, Need for insulating a duct and Duct system - Fans and blowers – Supply air outlets – Filters – Heating and cooling coils –AHU (Air handling units). –Chiller

Unit – 6 Applications of refrigeration and air conditioning – Recent trends in Refrigeration and air conditioning.

Duration: 13 Periods (L:10 – T:3)

Applications of refrigeration :- Domestic refrigerator– Water cooler –Desert/air cooler(Evaporative cooling), - Unitary vs Central Air conditioning system - Applications of air conditioning:-Window air conditioner, Summer air conditioning system – Winter air conditioning system – Central air conditioning system

Recent trends in RAC :Ice line refrigerator, chest refrigerator - Clean rooms vs Dry rooms - Variable refrigerant flow (VRF) system - Inverter AC – Smart HVAC controls – Natural ventilation.

REFERENCE BOOKS

1. Refrigeration and Air Conditioning – by C. PArora
2. Refrigeration and Air Conditioning – byDomakundwar
3. Basic Refrigeration and Air conditioning - by P NAnanthanarayana
4. Refrigeration and Air Conditioning – byDosatt
5. Refrigeration and Air Conditioning – byStoecker

SUGGESTED LEARNING OUTCOMES

1. **Introduction to refrigeration & air refrigeration systems**

1.1 Define the terms refrigeration and air conditioning
1.2 Know the difference between heat engine, refrigerator and heat pump.
1.3 Define the terms Refrigeration effect and Work of compression
1.4 Define COP
1.5 Expression for COP of refrigerator and heat pump and relation between them.
1.6 Define unit of refrigeration (Ton of refrigeration- TR).
1.7 Evaluate power required per ton of refrigeration
1.8 Numerical problems on COP , unit of refrigeration and power required per TR.
1.9 Know different natural methods and mechanical methods of refrigeration.
1.10 Explain such as direct ice and indirect ice method of refrigeration
1.11 Explain dry ice refrigeration system refrigeration
1.12 Introduction to Air refrigeration and list different air refrigeration systems.

1.13 Explain reverse Carnot refrigeration cycle with flow diagram, PV and TS diagram.
1.14 Know limitations of reverse Carnot refrigeration cycle.
1.15 Know expression for COP of reverse Carnot refrigeration cycle (derivation omitted)
1.16 Solve numerical problems on COP of reverse Carnot refrigeration cycle.
1.17 Explain Bell Coleman air refrigeration cycle with flow diagram, PV and TS diagram
1.18 Know expression for COP of Bell Coleman air refrigeration cycle (derivation Omitted)
1.19 Solve numerical problems on COP of Bell Coleman air refrigeration cycle

2. Vapour compression and absorption refrigeration Systems

2.1 List major components in simple (basic) vapour compression refrigeration system.
2.2 Draw flow diagram of simple (basic) vapour compression refrigeration system.
2.3 Explain principle and working of simple (basic) vapour compression refrigeration system with the help of T-S and P-h diagrams.
2.4 Write the expression for COP of vapour compression system.
2.5 Distinguish between wet and dry compression.
2.6 Solve simple problems on basic vapor compression refrigeration system
2.7 Summarize the effects of evaporator pressure and condenser pressure on COP
2.8 Summarize the effects of under cooling and super heating on COP.
2.9 State the use of receiver, accumulator, strainer, drier and flash chamber.
2.10 Explain principle of simple vapor absorption systems.
2.11 State the desirable properties of refrigerants -absorbers
2.12 List commonly used refrigerant – absorber pairs.
2.13 Explain the construction and working of Ammonia-Water VARS
2.14 Explain the construction and working of Water-Lithium Bromide VARS.
2.15 Know expression of COP of VARS (without derivation)
2.16 Solve simple problems on COP of VARS.

3. Refrigerants and refrigeration equipment

3.1 Distinguish between primary and secondary refrigerants.
3.2 List the desirable properties of refrigerants and Classify refrigerants.
3.3 Know the difference between chlorofluoro carbon refrigerants, hydro chlorofluro refrigerants and hydro carbon refrigerants.
3.4 Write chemical formula, designation name and application of the following refrigerants – R 12, R 22, R 134 a, R 290a, R 600a, R 401a, R 410 a, R 717, R 718, R 729, R 744.
3.5 Know the impact of refrigerants on Ozone depletion – Need to phase out of Chlorofluoro carbons and hydro Chlorofluoro carbons –
3.6 Understand Montreal protocol (Statement of protocol)

3.7 Know the effect of refrigerants on Global warming .
3.8 Understand Kyoto protocol. (Statement of protocol).
3.9 Know the application of reciprocating, scroll, screw and centrifugal compressors.
3.10 Explain construction and working of hermetic reciprocating compressor.
3.11 State the function of condenser, know difference between air cooled condenser and water cooled condenser – know difference between natural circulation and forced circulation condenser.
3.12 Explain the working of natural circulation tube and fin air cooled condenser used in domestic refrigerator.
3.12 Explain the working of forced circulation tube and fin air cooled condenser used in window air conditioner/water cooler.
3.13 Explain the working of shell & tube water cooled condensers used in big capacity refrigeration/air conditioning systems.
3.14 Explain the working of evaporative condensers used in ice making plants..
3.15 Explain the working of capillary tube.
3.16 Know the difference between direct evaporator and flooded evaporator.
3.17 Explain the working plate surface evaporator used in domestic refrigerator/ display panel in bakeries..
3.18 Explain the working of bare tube evaporator used in water cooler.
3.19 Explain the working of finned tube forced circulation evaporator used in window air conditioner.
3.20 Explain the working of shell and tube evaporator used in big capacity refrigeration/air conditioning plants.

4.Air conditioning &Psychrometry

4.1 Define air conditioning and classify air conditioningsystems
4.2 Know the following terms: human comfort, effective temperature
4.3 Know about comfortchart.
4.4 Define the terms: Psychrometry, dry air and moist air, DBT, WBT, DPT and adiabatic saturation temperature
4.5 Define the terms humidity, absolute humidity, relative humidity, specifichumidity.
4.6 Know carrier's equation and solve problems involvingpsychrometry.
4.7 Construction and working of different psychrometers- Laboratory, continuous recording, sling, aspirating psychrometers.
4.8 Explain the features of psychrometric chart, plot all psychometric processes on the chart.
4.9 Simple problems on psychrometric processes using psychrometric chartonly.
4.10Know the concept of mixing of air streams and solveproblems.

5.Air distribution and Air conditioning equipment

5.1 Draw the general air flow diagram for AC system and explain flow of air.

5.2 Explain different air distribution systems in a room like ejection system, downward system and upwardsystem.

5.3 Air distribution system in a Room :- Ejection system,

5.4 Air distribution system in a Room :- Downward system

5.5 Air distribution system in a Room: Upward system.

5.6 Explain the need of duct- Know duct materials, shapes and classifyducts

5.7 Explain need of insulating a duct and material used for insulation.

5.8 Explain the duct system based on arrangement of supply ducts loop perimeter system

5.9 Explain the duct system based on arrangement of supply : radial perimeter system

5.10 Explain the duct system based on arrangement of supply ducts :extended plenum system.

5.11 Explain duct system based upon number of ducts used like: single duct system, dual duct system and dual duct with inductionsystem.

5.12 Differentiate fan andblower.

5.13 Know the factors governing selection offans.

5.14 Classify fans according to direction of airflow.

5.15 Know about grill outlets, slot diffusers, ceiling diffusers, perforated ceiling panels and theirapplications.

5.16 Know different types of filters (Dry, Viscous, Wet, Electronic and HEPAfilters)-

5.17 Explain heating and coolingcoils.

5.18 Know about air handling unit(AHU).

5.19 Know the function of chillers in airconditioning.

6. Applications of refrigeration and air conditioning – Recent trends in Refrigeration and air conditioning

6.1 Explain construction and working of domesticrefrigerator.

6.2 Explain construction and working of storage type watercooler.

6.3 Know about ice line refrigerator and chest freezer.

6.4 Explain the working of desert type aircooler.

6.5 Explain difference between unitary and central ac system.

6.6 Explain working of window airconditioner.

6.7 Know the difference between unitary air conditioner, split airconditioner and cassette air conditioning system.

6.8 Explain summer air conditioning system for hot &humid out door conditions and hot & dryconditions.

6.9 Explain winter air conditioning system for cold & dry out doorconditions

6.10 Explain central air conditioningsystem

6.11 Know the difference between clean room and dry room.

6.12 Know about variable refrigerant flow (VRF) system.

6.13 Know about inverter ac system.

6.14 Explain briefly smart HVAC system.

6.15 Explain briefly about Natural ventilation system.

CO – PO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1.50	1.50	3.00	3.00	1.50	1.50	3.00
CO2	1.50	3.00	3.00	3.00	1.50	3.00	3.00
CO3	3.00	3.00	1.50	1.50	3.00	3.00	1.50
CO4	3.00	3.00	1.50	1.50	3.00	3.00	1.50
CO5	3.00	1.50	1.50	3.00	3.00	3.00	1.50
CO6	3.00	1.50	1.50	1.50	3.00	3.00	1.50
AVERAGE	**2.50**	**2.25**	**2.00**	**2.25**	**2.50**	**2.75**	**2.00**

BOARD DIPLOMA EXAMINATIONS (C 24)
MID SEM I EXAMINATION
DME V SEMESTER
REFRIGERATION AND AIR CONDITIONING

Time : 1 Hour **Total Marks : 20 M**

PART – A Marks: 4 X 1M = 4 M

*NOTE: 1) Answer **all** questions and each question carries **one** mark.*

*2) Answers should be brief and straight to the point and shall not exceed **three** simple sentences*

1. Define the term Ton of refrigeation.?
2. Find COP of a heat pump working on Reverse Carnot cycle operating between -10° C and 40° C?
3. What is function of accumulator in VCRS?
4. In Water- Lithium bromide VARS which Refrigerant is used?

PART – B

Marks: 2 X 3M= 6 M

*NOTE: 1) Answer **all** questions and each question carries **three** marks*

2) The answers should be comprehensive and the criteria for valuation is the content

but not the length of the answer.

5.(a). Explain about ice refrigeration

OR

5. (b).Draw PV and TS diagram of refrigerator of reverse Carnot air refrigeration cycle.

6 a). Draw the layout of Ammonia – water VARS..

OR

6 (b). Why is water Lithium bromide VARS is limited to be used only for air conditioning?

PART – C

Marks : 2 X 5 M = 10 M

NOTE :

1. Answer **all** questions and each question carries **five** marks.

2. The answers should be comprehensive and the criteria for valuation is the content but not the length of the answer

7(a) Explain Bell Coleman refrigeration cycle with a layout.

OR

7(b) A refrigeration plant works between – 15°C and 30°C. The refrigerant is dry and saturated at the end of compression. Calculate Refrigerating effect, Carnot COP and COP of VARS, if enthalpy values before and after compression are 1280 kJ/kg and 1470 kJ/kg, fluid enthalpy at 30°C is 320 kJ/kg.

8 (a) Explain with help of Pressure-Enthalpy (P-H) diagram the effect of increase in condenser pressure on refrigeration system performance.

OR

8 (b) Differentiate between wet compression and dry compression refrigeration system.

BOARD DIPLOMA EXAMINATIONS (C 24)
MID SEM II EXAMINATION
DME V SEMESTER
REFRIGERATION AND AIR CONDITIONING

Time : 1 Hour **Total Marks : 20 M**

PART – A Marks: 4 X 1M = 4 M

*NOTE: 1) Answer **all** questions and each question carries **one** mark.*

*2) Answers should be brief and straight to the point and shall not exceed **three** simple sentences*

1. What is a secondaryrefrigerant. Give an example.
2. What is chemical name of R- 290.
3. Defineair conditioning ?
4. Define the term relative humidity.

PART – B

Marks : 2 X 3M= 6 M

*NOTE: 1) Answer **all** questions and each question carries **three** marks*
2) The answers should be comprehensive and the criteria for valuation is the content but not the length of the answer.

5. (a)Write short notes on KYTO protocol

OR

5 (b) When are forced circulation water cooled condensers used in air conditioning systems.

6. (a) How does Dry bulb temperature change in sensible cooling and sensible heating.

OR

6 (b)Write carrier's equation used in air conditioning and indicate the terms used in it?.

PART – C

Marks : 2 X 5 M = 10 M

NOTE :

3. Answer **all** questions and each question carries **five** marks.
4. The answers should be comprehensive and the criteria for valuation is the content but not the length of the answer

7(a) Explain working of Hermetic compressor.

OR

7(b) Explain working of capillary.

8 (a) A air conditioning system requires air which is at DBT 35C . Without changing its specific humidity, its temperature should change to 15 C. Indicate the process on Psychrometric chart and name the process?

OR

8 (b) Explain the difference between humidification and dehumidification.

BOARD DIPLOMA EXAMINATIONS (C 24)
MODEL PAPER (SEE)
DME V SEMESTER
REFRIGERATION AND AIR CONDITIONING

TIME : 2 Hours Max. Marks: 40

PART – A Marks: 8 X 1 M = 8 M

*NOTE : 1)Answer **all**questions and each question carries **one** marks.*
*2)Answers should be brief and straight to the point and shall not exceeding **three**simple sentences*

1. Define the term refrigeration.
2. What is the function of flash chamber in VCRS.
3. Why is an air conditioning duct need to be insulated.
4. Write equation to find humidity of air.
5. What is function of a duct inconditioning systems..
6. What is approximate value of relative humidity of Vishakapatnam?.
7. What are main components in out doorunit of split air conditioner?
8. What psychrometric process does air under go in air cooler ?

PART – B

*Answer **all** questions . Each question carries **three** marks*

4x 3 M = 12M

9(a) COPof refrigerator working on reverse Carnot cycle is 5. What is the value of ratio of high temperature and low temperature of the cycle.

OR

9(b) What does HEPA stands for? Why it is used.

10(a) What are primary refrigerants give two examples.

OR

10 (b) Draw layout of components in window air conditioner?

11 (a) Differentiate slot diffuser and ceiling diffuser.

OR

11(b) Differentiate radiation and convection heat transfer

12(a) Draw the layout of summer air conditioning system.

OR

12(b) Draw the layout for domestic refrigerator.

PART – C

*Answer **all** questions. Each question carries **five** marks*

4x 5 M = 20 M

13 (a) Explain reverse Carnot air refrigeration cycle?

OR

13 (b) Explain loop perimeter duct system with a neat sketch.

14 (a) Explain working of thermos static expansion valve.

OR

14 (b) Explain working of window air conditioner.

15 (a) Explain general air distribution system.

OR

15 (b) Explaindual duct air conditioning system.

16 (a) Explain winter air conditioning system ?

OR

16 (b) Write short notes on clean rooms and dry rooms?

ME-503-COMPUTER AIDED DESIGN AND MANUFACTURING

Course Title:	Computer Aided Design And Manufacturing	Course Code:	ME-503
Semester:	V	Course group :	Core
Teaching Scheme(L:T:P):	4:1:0	Credits:	2.5
Methodology:	Lecture+ Assignment	Total contact Periods:	75
CIE:	60 Marks	SEE:	40 Marks

Prerequisites: Basic knowledge of Computers.

COURSE OUTCOMES

At the end of the course the students will be able to :	
1	Apply computer-aided design (CAD) and manufacturing (CAM) software to create, analyze, and optimize product designs, as well as implement production planning techniques for efficient manufacturing.
2	Evaluate and implement advanced CNC machining techniques for efficiency and flexibility, including programming, cloud integration, and cobot collaboration.
3	Master machining centers and their CNC components for effective operation within Industry 4.0, including maintenance, advanced materials, and IoT integration.
4	Program CNC lathes and mills, covering coordinate systems, machine-specific structures, G/M-codes, canned cycles, subroutines, macros, and automated toolpath generation.
5	Gain expertise in applying CIMS principles, functions, and implementation strategies while evaluating advanced technologies like AI, Big Data, CAI for manufacturing process optimization.
6	Evaluate the components, classifications, and industrial applications of robotic and automation systems (AGVs, ASRS), exploring their integration within CIM and the impact of artificial intelligence on manufacturing capabilities.

COURSECONTENTANDBLUEPRINTOFMARKSFORSEE

Unit No	Unit Name	Periods	Questions to be set for SEE(Q No)					Remarks
			R			U	A	
1	**Introduction to Computer Aided Design and Manufacturing**	13	4	1		9(a)	13(a)	
2	**Introduction to NC, CNC and DNC Machines**	13						
3	**CNC Machines and their Components**	12		2		10(a)	14 (a)	
4	**CNC Part Programming**	13						
5	**CIMS, FMS and CAI**	12		3	5 ,6	9(b), 11(a), 11(b)	13(b), 15(a), 15(b)	
6	**Fundamentals of Robotics and Automation**	12			7 , 8	10(b), 12(a), 12(b)	14(b), 16(a), 16(b)	

Legend: R Remembering, U:Understanding A:Applying

COURSE CONTENTS

Unit – 1

INTRODUCTION TO COMPUTER AIDED DESIGN AND MANUFACTURING

Introduction to Computer Aided Design (CAD): Introduction to CAD, Parametric Modeling & Generative Design, Benefits of CAD, Stages of CAD - Simulation Techniques: Introduction to simulation, Types of simulations, Finite Element Analysis (FEA), Digital twins, Virtual reality/augmented reality (VR/AR), applications in design and production.

Introduction to Computer Aided Manufacturing (CAM): Introduction to CAM, Functions of CAM, Benefits of CAM, Fundamentals of Computer Aided Process Planning, CAPP and Types of CAPP : Generative and Retrieval, MRP I, MRP II, ERP, SAP, Comparison of MRP I, MRP II, ERP and SAP.

Unit-2

INTRODUCTIONTO NC AND CNC MACHINES

Numerical Control (NC) System: Introduction to Numerical Control (NC) System , Parts of NC System with a block diagram, Advantages and limitations of NC system.

Computer Numerical Control (CNC) Machining: Introduction to CNC, Manufacturing methodology of Modern CNC Machining, Advanced programming techniques, Cloud computing for CNC machines, Classification of CNC Machining centers, Block diagram of

CNC system, Functions of each components of CNC system, Advantages and Disadvantages of CNC over NC, Applications of CNC.

Direct Numerical Control (DNC) systems: Basic concept of DNC, Block diagram of DNC system with basic components, working principle, Concept of DNC system with and without satellite, Functions of DNC, Advantages of DNC - Collaborative robots (cobots) - Comparison between NC, CNC and DNC Machine tools.

Unit-3

CNCMACHINES ANDTHEIR COMPONENTS

Machining Centers (MC): Types, Construction features of machining centres specification of MC - Components of CNC: Automatic tool changer, working of Tool gripper, tool magazine, types of tool magazines, Automatic pallet changer, Care and maintenance of CNC machines, Spindle drives, feed drives, Slide ways, types with illustrations, Bearings, linear motion bearings, recirculatory ball screws - Advanced materials for reduced friction and wear - Feedback devices - integration with IoT and Industry 4.0 standards - transducers, encoders, linear transducers.

Unit-4

CNC PART PROGRAMMING

Introduction to CNC Lathe and Milling, Steps involved in CNC Lathe and Milling Programming, Types of Part Programs: Manual and Computer Assisted, CNC Part Programming languages Lathe and Milling, CNC coordinate system: NC axis system for milling, drilling and turning, Coordinates referencing methods: Absolute positioning, Incremental positioning, Concept of Fixed point zero, Floating point zero.

NC Part Programming(Lathe & Milling): Structure of NC Part Programming, Standard NC Functions/Words used in NC Part Programming language , Preparatory functions (G Codes) : Interpolation and Types , Linear Interpolation , Circular Interpolation , Cutter/Tool Compensation , Miscellaneous functions (MCodes) , Part programming formats , Canned cycles in Lathe & Milling, Subroutines in Lathe & Milling , Macros in Lathe & Milling, Example problems on Preparatory functions (G Codes), Miscellaneous functions (MCodes), Canned cycles, Subroutines, Macros in Lathe & Milling - Automated Tool Path Generation.

Unit-5

CIMS, FMS and CAI

Computer integrated manufacturing system: Introduction, Definition of CIM, Various process involved in CIM – CIM Cycle with integration of all functions, Importance, Necessity and features of CIMS, Flexible Manufacturing System(FMS): Definition, Application characteristics of FMS, Need of FMS, Basic Components of FMS, Features of FMS, Advantages of FMS, Limitations of FMS, Computer Aided Inspection: Introduction to CNC-CMM, features, working, advantages of CNC-CMM.

CIM Software’s, Big Data, AI, Machine Learning and Edge Computing in CIM, Computer

Aided Inspection (CAI): Introduction, CAI Techniques, Integration of CAI in CIM.

Unit-6

FUNDAMENTS OF ROBOTICS AND AUTOMATION

Robotics: Definition of a robot, necessity, Degrees of freedom (DOF) of Robot, Classification of Robots: Definition of each robot under each classification, Basic Components of a Robotic System, Manipulator and Working, End Effectors: Different Grippers and Tools, Applications of Industrial Robots, Disadvantages, Role of robots in CIM, Artificial intelligence (AI) in robotics,

Automation: Automatic Guided Vehicles: Introduction, process control, Sensors and data acquisition, Simple AGV System, Components of AGV system, Types of AGVs, Automatic Storage and Retrieval System (ASRS): Introduction, Components of ASRS, Advantages of ASRS.

REFERENCE BOOKS:

- Computer Integrated Design and Manufacturing, McGrawHill –BedworthDavid.D Computer Integrated Manufacturing, PHI – Paul G. Ranky
- Industrial Robotics, PHI–Gordon.N.Mair
- NumericalControlAndComputerAidedManufacturing,TMH–T.K.Kundra,P.N. Rao
- Computer Aided Manufacturing, TMH–T.K.Kundra, P.N.RaoCNCMachines, New Age – B.S. Pabla and M. Adithan
- CAD,CAM,CIM byRadha Krishnan.

SUGGESTED LEARNING OUTCOMES

On completion of the course the student should be able to

1. **Understand the basic concepts of Computer aided Design (CAD) and Computer Aided Manufacturing**
   - 1.1. Define CAD and its role in product design and development.
   - 1.2. Explain the key advantages of using CAD in various industries (e.g., increased precision, design iteration, collaboration).
   - 1.3. List and describe the different stages of the CAD process (conceptualization, modeling, analysis, documentation).
   - 1.4. Explain the principles of parametric modeling and how they are used to create flexible designs.
   - 1.5. Demonstrate basic proficiency in using a CAD software to create simple 3D models.
   - 1.6. Apply parametric modeling techniques to modify and refine 3D models.
   - 1.7. Describe the concept of generative design and identify software tools used for this process.
   - 1.8. Utilize generative design techniques to explore a range of design solutions based on defined constraints.
   - 1.9. Define simulation and explain its importance in the design process.
   - 1.10. Differentiate between various types of simulations (FEA, digital twin, VR/AR).
   - 1.11. Describe real-world applications of simulation techniques in design and production.
   - 1.12. Define CAM and its role in the manufacturing process.

1.13. List the primary functions of CAM systems.
1.14. Explain the advantages of CAM in manufacturing (e.g., increased efficiency, reduced waste, improved quality).
1.15. Describe the basic concepts of Computer-Aided Process Planning (CAPP).
1.16. Distinguish between generative and retrieval CAPP systems.
1.17. Define Material Requirements Planning (MRP I) and Manufacturing Resource Planning (MRP II).
1.18. Describe the key components and functions of MRP I and MRP II systems.
1.19. Define Enterprise Resource Planning (ERP) and outline its functions.
1.20. Explain SAP and outline its functions.
1.21. Construct a table that compares and contrasts MRP I, MRP II, ERP, and SAP.

2. Understand the Concepts of NC, CNC and DNC systems

2.1. Define Numerical Control (NC) and explain its basic principles.
2.2. Describe the key components of an NC system and illustrate their functions with a block diagram.
2.3. List the advantages and limitations of NC systems compared to conventional machining.
2.4. Explain the different types of motion control in NC systems (point-to-point, continuous, and contouring), providing examples of their applications.
2.5. Define Computer Numerical Control (CNC) and explain how it differs from NC.
2.6. Describe the evolution of CNC systems and their impact on manufacturing.
2.7. Explain the working principles of a CNC system, including the functions of key components (e.g., controller, machine tool, feedback devices).
2.8. Identify the advantages and disadvantages of CNC systems compared to NC systems.
2.9. List and describe various applications of CNC machining in different industries.
2.10. Define Direct Numerical Control (DNC) and explain its role in manufacturing networks.
2.11. Draw a block diagram of a DNC system and label its basic components.
2.12. Describe the working principles of DNC systems, including options with and without satellite computers.
2.13. List the advantages of using DNC systems in manufacturing environments.
2.14. Describe the role of cloud computing in modern CNC machining.
2.15. Explain the principles and applications of collaborative robots (cobots) in manufacturing.
2.16. Construct a table comparing and contrasting NC, CNC, and DNC systems in terms of features, capabilities, advantages, and limitations.

3. Familiar with the CNC Machines and Components and Attachments

3.1. Define the term "Machining Center" and describe its key functions in manufacturing.
3.2. Identify the different types of machining centers (e.g., horizontal, vertical, universal) and explain their applications.
3.3. Describe the major components of a machining center and illustrate their roles within the system.
3.4. Explain the principles behind automatic tool changers (ATCs), including their components and benefits.
3.5. Describe different tool magazine types and how they function within an ATC system.
3.6. Explain the concept of an automatic pallet changer (APC) and outline its advantages for production efficiency
3.7. Compare and contrast stepper motors and servo motors in CNC applications, focusing on accuracy and suitability for different tasks.

3.8. Describe various slide way types used in CNC machines and explain their impact on machine precision.
3.9. Explain the function of linear motion bearings and recirculating ball screws in CNC machines.
3.10. Identify common feedback devices used in CNC systems and explain their role in closed-loop control.
3.11. Describe the different types of transducers (linear and rotary) and explain their applications in CNC position feedback
3.12. Outline essential maintenance procedures for CNC machines to ensure optimal performance and longevity.
3.13. Identify advanced materials used in CNC components to reduce friction and wear, and discuss their benefits.
3.14. Explain how CNC technologies integrate with IoT and Industry 4.0 standards, enabling real-time monitoring and data-driven manufacturing.

4. Familiar with the CNC Part Programming concepts

4.1. Understand the basics of CNC Lathe and Milling machines.
4.2. Identify the steps involved in programming for CNC Lathe and Milling.
4.3. Differentiate between Manual and Computer-Aided Part Programming methods.
4.4. Explore various CNC Part Programming languages for Lathe and Milling.
4.5. Grasp the concept of CNC Coordinate Systems for Milling, Drilling, and Turning.
4.6. Understand Absolute and Incremental Coordinate Referencing methods.
4.7. Differentiate between Fixed and Floating Zero Point in CNC machining.
4.8. Learn the Structure of NC Part Programs for Lathe and Milling.
4.9. Identify Standard NC Functions (G & M Codes) used in Part Programming.
4.10. Understand Preparatory Functions (G Codes) and their types (Linear & Circular Interpolation).
4.11. Explore the concept of Cutter/Tool Compensation in CNC machining.
4.12. Grasp the functionalities of Miscellaneous Functions (M Codes).
4.13. Analyze different Part Programming Formats.
4.14. Understand Canned Cycles used in Lathe and Milling Programming.
4.15. Learn about Subroutines and Macros in Lathe and Milling.
4.16. Solve example problems using G-codes, M-codes, Canned Cycles, Subroutines, and Macros.
4.17. Understand the concept of Automated Tool Path Generation in CNC machining.

5. Understand the concepts of CIMS, FMS and CAI

5.1. Define CIM and understand its role in modern manufacturing.
5.2. Explain the CIM cycle, highlighting the integration of various processes.
5.3. Analyze the importance, necessity, and key features of CIMS.
5.4. Define FMS, its application characteristics, and the need for its implementation.
5.5. Identify the basic components and features of a Flexible Manufacturing System.
5.6. Evaluate the advantages and limitations ofFlexible Manufacturing System.
5.7. Explain the concept of Computer-Aided Inspection using CNC Coordinate Measuring Machines.
5.8. Analyze the features, working principle, and advantages of CNC-CMM technology.
5.9. Identify the role of CIM software, Big Data, AI, Machine Learning, and Edge Computing in a CIM system.
5.10. Define Computer-Aided Inspection (CAI) and explore its techniques and integration within CIM.

6. **FamiliarwiththefundamentalsofRobots,AutomatedStorageandRetrieval Systems and Automated Guided Vehicles (AGVs).**
   - 6.1. Define a robot.
   - 6.2. Understand the necessity of robots.
   - 6.3. Grasp the concept of Degrees of Freedom (DOF) of a robot.
   - 6.4. Classify robots and understand the definition of each type.
   - 6.5. Identify basic components of a robotic system.
   - 6.6. Illustrate manipulator function.
   - 6.7. Explore end effectors types (grippers & tools).
   - 6.8. Analyze applications of industrial robots.
   - 6.9. Understand the disadvantages of industrial robots.
   - 6.10. Explore the role of robots in CIM.
   - 6.11. Understand Automation: Process control in AGVs.
   - 6.12. Understand Automation: Sensors and data acquisition in AGVs.
   - 6.13. Describe a simple AGV system and its components along with different AGV types.
   - 6.14. Define Automatic Storage and Retrieval System (ASRS), its components, and advantages.

SUGGESTED E RESOURCES / STUDENT ACTIVITIES

- A Visit to a nearest Industry working on CNC Machines.
- Identify various machine tools including CNC and write the report differentiating an ordinary machine tool with CNC machine tool
- Write a part program for producing work pieces like round rods, stepper rods and screwed fasteners etc.
- www.nptel.ac.in
- www.coursera.com

Course Outcomes		CL	Linked PO	Teaching Hours
CO1	Apply computer-aided design (CAD) and manufacturing (CAM) software to create, analyze, and optimize product designs, as well as implement production planning techniques for efficient manufacturing.	U/A	1,2,3,4,5,6,7	13
CO2	Evaluate and implement advanced CNC machining techniques for efficiency and flexibility, including programming, cloud integration, and cobot collaboration.	U/A	1,2,3,4,5,6,7	13
CO3	Master machining centers and their CNC components for effective operation within Industry 4.0, including maintenance, advanced materials, and IoT integration.	U/A	1,2,3,4,5,6,7	12
CO4	Program CNC lathes and mills, covering coordinate systems, machine-specific structures, G/M-codes, canned cycles, subroutines, macros, and automated toolpath generation.	A	1,2,3,4,5,6,7	13
CO5	Gain expertise in applying CIMS principles, functions, and implementation strategies while evaluating advanced technologies like AI, Big Data, CAI for manufacturing process optimization.	U/A	1,2,3,4,5,6,7	12
CO6	Evaluate the components, classifications, and industrial applications of robotic and automation systems (AGVs, ASRS), exploring their integration within CIM and the impact of artificial intelligence on manufacturing capabilities.	A	1,2,3,4,5,6,7	12

CO – PO MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	2	1	2
CO2	2	3	2	2	2	2	1
CO3	2	2	3	2	2	3	1
CO4	2	3	3	3	2	2	1
CO5	2	2	2	2	3	2	2
CO6	2	2	2	2	2	3	2

ME-503

BOARDDIPLOMAEXANIMATIONS,(C24)

Model Paper :COMPUTER AIDED DESIGN AND MANUFACTURING

Mid Sem-I(CIE)

Time:1Hour **TotalMarks:20 M**

PART – A

Marks:4 X1M=4M

*NOTE: Answer **all** questions and each question carries **one** mark.*

1. Define CAD
2. Define MRP-II.
3. Write one limitation of the NC System
4. What is the full form of DNC?

PART – B

Marks:2 X3M=6M

*NOTE:Answer**all**questions andeachquestioncarries**Three**marks*

5(a). Explain the principles of parametric modelling.

Or

5(b). Listanythree advantagesofCAPP.

6(a). List three different types of motion control in NC systems.

Or

6(b). ListanythreelimitationsofNCoverconventional machining.

PART – C

Marks:2 X 5M= 10M

*NOTE:Answer**all** questionsandeachquestioncarries **Five**marks.*

7(a). Listanyfivefeaturesof CAD packages.

Or

7(b). Explain theconcept of SAP briefly.

8(a). DrawtheBlockDiagramoftheCNCMachiningsystemandlabelallthe components.

Or

8(b). Listanyfiveadvantagesof DNC.

BOARDDIPLOMAEXANIMATIONS,(C24)

ModelPaper: COMPUTER AIDED DESIGN AND MANUFACTURING

MidSem-II(CIE)

Time:1 Hour **TotalMarks : 20 M**

PART – A

Marks:4 X1M=4M

*NOTE:Answer**all** questionsandeachquestioncarries **one**mark.*

1. Whatisthefull formofATC relatedtoCNC Machining?
2. Writetheuseof CNCAutomaticPallet Changer.
3. Whatisthe meaningofthe‘S2000’CNC word?
4. MentionthefunctionsofG-CodesG00and G01.

PART – B

Marks:2 X3M=6M

*NOTE:Answer**all**questions andeachquestioncarries**Three**marks*

5(a). Write anythreeCNC Machiningcentercomponents

Or

5(b). Specifythefunction of the CNCSpindle drive

6(a). Whatis T-Word inCNC part programming?

Or

6(b). Whatis circularinterpolation in theCNC part program?

PART–C

Marks:2 X5M= 10M

*NOTE:Answer**all** questionsandeachquestioncarries **Five**marks.*

7(a). DrawaneatsketchofAutomatic ToolChanger (ATC).

Or

7(b). Writeashort noteon the following

i)Servomotorii)Stepper motor

8(a). Brieflyexplainthe Co-OrdinatesReferencingMethodsin CNC.

Or

8(b). WritetheStepsInvolvedin CNCPart Programming.

ME-503

BOARDDIPLOMAEXANIMATIONS,(C24)

SEMESTER END EXAMINATION (SEE)

ModelPaper: COMPUTER AIDED DESIGN AND MANUFACTURING

*Time:*2Hours TotalMarks:40

PART-A

Marks: 8X01=08

Instructions: 1.Answer**ALL**questions.

2.Eachquestioncarries **ONE** mark.

1. Mentionanythreeadvantages of CAD.
2. Definenumericalcontrol.What arethebasiccomponentsofNCsystem?
3. Whatis thefull formof ASRS?
4. Whatis theactuatorofaRobot?
5. FMSisbestsuited for?
6. Define CIM and write its role in modern manufacturing.
7. What is arobot?
8. Whatis thefull formof AGV?

PART-B

Marks: 04X03=12

Instructions:1.Answer any**FOUR**questions.

2.EachquestioncarriesTHREE marks.

9(a). Explainvariousstagesinvolvedindesignofacomponentusing CAD.

(or)

9(b). MentiontheimportanceofComputerIntegratedManufacturingSystem(CIMS).

10(a). HowdoyoucallaP2000Subroutinerepeating6 times in CNC Lathe program?

(or)

10(b). ClassifytheRobots as perthe Degrees of Freedom.

11(a). MentiontheimportanceofComputerIntegratedManufacturing System (CIMS)

(or)

11(b). Define Computer-Aided Inspection (CAI) and write its techniques.

12(a). Write ashort note onSCARA Robot.

(or)

12(b). Draw and name the basic components of a robotic system.

PART-C

Marks: 04X5=20

Instructions: 1.Answer any**FOUR**questions.

2.Eachquestioncarries**FIVE**marks.

13(a). What is MRP-II? Explain in detail various functions of MRP-II.

(or)

13(b). Draw a neat sketch of CNC-CMM and explain the working procedure of CNC-CMM.

14(a). Explainindetailtheprocedureinvolvedincomputeraidedpart programming.

(or)

14(b). Draw aneat sketch ofaRobot showingSixDegreesof freedomin motion

15(a). Draw aFigureshowingtheapplicationcharacteristicsof FMS.

(or)

15(b). Explain the role of CIM software, Big Data, AI, Machine Learning, and Edge Computing in a CIM system.

16(a). Classifythe Robots asper theWorkspace Geometry.

(or)

16(b). Brieflyexplain the componentsof the AS/RS system.

ME-504-FLUID POWER SYSTEMS

Course Title:	Fluid Power Systems	Course Code:	ME-504
Semester:	V	Course group:	Core
Teaching Scheme(L:T:P):	4:1:0	Credits:	3
Methodology :	Lecture + Assignment	Total contact periods:	75
CIE:	60 Marks	SEE:	40 Marks

Prerequisites

Basic Knowledge of hydraulics, pneumatics, and control systems

Course Outcome

On successful completion of the course, the students will be able to attain below Course Outcome (CO):

Course Outcome	
CO1	Explain and Evaluate Hydraulic and Pneumatic Pump
CO2	Explain and differentiate Hydraulics motors
CO3	Describe the construction of various directional, Pressure and Flow control valves.
CO4	Hydraulic circuit design and Analysis.
CO5	Understand and explain Actuators
CO6	Design the single Actuator Circuits

Blue Print of Marks for SEE

Unit Name		Questions to be set for SEE Marks					Remarks
		periods	R		U	A	
PART-A	Introduction to hydraulics and pumps	13	Q4	Q1	9(a)	13(a)	
	Hydraulic Motors and Actuators	12					
PART-B	Directional pressure and flow control valves	13		Q2	10(a)	14(a)	
	Hydraulic circuit design and analysis	12					
PART-C	Introduction to pneumatics and actuators	13		Q3 Q5 Q6	9(b) 11(a) 11(b)	13(b) 15(a) 15(b)	
	Single Actuator circuits	12		Q7 Q8	10(b) 12(a) 12(b)	14(b) 16(a) 16(b)	
TOTAL		75	10	8	06	06	

COURSE CONTENT

UNIT-I

Introduction to Hydraulics and Hydraulic pumps

Definition and scope of fluid power, Advantages, and drawbacks of fluid power, Applications of fluid power, Components of Fluid power system - Comparison between Hydraulic and Pneumatic Systems, Comparison of Different Power Systems -mechanical, electrical, hydraulic and pneumatic power systems, Future of Fluid power industry - in general and related to India. – Elements of the hydraulic system - Classification of pumps based on Displacement, Delivery and Motion, Positive and Non-positive displacement pumps, Advantages and disadvantages of Non-positive displacement pumps Differences between Positive and Non positive displacement pumps, Classification of positive displacement pumps Pumping Theory, Gear pumps - External and internal gear pumps, Lobe and Screw pumps, Advantages, Disadvantages and applications of the above pumps, Vane pumps - Unbalanced and Balanced vane pumps, Advantages, Disadvantages and applications of vane pumps, Piston Pumps - Axial and Radial Piston Pumps Bent - Axis type and Swash - P Advantages, Disadvantages and applications of vane pumps, plate type piston pumps, Advantages, Disadvantages and applications of piston pumps, Volumetric and Mechanical efficiencies of pumps.

UNIT-2

Hydraulic Actuators

Introduction- Differences between hydraulic pump and motor, Classification of actuators, Types of hydraulic cylinders – Single acting - Gravity return and spring return single acting cylinders, Double-acting - Piston rod on one side and both the sides, Telescope and Tandem cylinders Applications of hydraulic motors, Comparison between hydraulic and electric motors, Classification of hydraulic motors, Gear motors, Vane motors, Piston motors, Semi rotary actuators, Rack & pinion, parallel piston and vane type Theoretical torque, power and flow rate, Volumetric, Mechanical and Overall efficiencies of hydraulic motor. Introduction-, Cylinder force, velocity and power, First, Second, and Third Class lever systems used in cylinders, Cylinder cushions and it's importance.

UNIT-3

Directional, pressure, and Flow control valves

Introduction to valves used in fluid power, Functions of direction control valves, Classification of direction control valves on different criteria, Classification of DCVs based on Fluid Path, Design Characteristics, Control Method, Construction of Internal Moving Parts, Symbols of various direction control valves, Different types of actuators - Manually operated, mechanically operated, Solenoid operated and Pilot operated actuators, Check valve – construction and operation details of Ball type, Poppet, Pilot operated, Two way and Three-way control valves and their applications. Necessity and functions of pressure control valves, Classification of pressure control valves, Pressure relief valves - construction and working of simple and compound (pilot operated) pressure relief valves, Pressure reducing valves, Unloading valves - Direct Acting and Pilot operated unloading valves - construction and operation, Counterbalance valves, Pressure sequence valves, Cartridge valves - Balanced and unbalanced poppet controlled cartridge valves, Applications of pressure control valves. Functions of flow control valves, Classification of flow control valves, Construction and operation of non-pressure compensated and Pressure compensated flow control valves.

UNIT-4

Hydraulic accessories, circuit design, and Analysis

Hydraulic accessories - tanks, coolers and heaters, filters, monitoring elements, and accumulators. Describing the operation of complete hydraulic circuits drawn using graphic symbols for all components, Control of single-acting hydraulic cylinder, Control of double-acting hydraulic cylinder, Regenerative cylinder circuit – expression for the cylinder extending speed, Load carrying capacity during extension, Pump unloading circuit, Double - pump hydraulic circuit, Counterbalance valve application, Hydraulic cylinder sequencing circuit, Cylinder synchronizing circuits - cylinders connected in parallel and series, fail-safe system with overload protection, Two-handed safety system.

UNIT-5

Introduction to Pneumatics and Actuators

Introduction to Pneumatics, Choice working medium and system, Advantages and disadvantages of compressed air, Applications of pneumatics, Basic components of pneumatic systems, Advantages and disadvantages of pneumatic systems, Comparison of

Mechanical / Electrical, Hydraulic and Pneumatic transmission systems Introduction to pneumatic actuators, Types of pneumatic actuators – Linear actuators (pneumatic cylinders), Rotary actuators (Air motors) and Limited angle actuators, Classification of Linear actuators based on, Application for which cylinders are used, cylinder's action, cylinder's movement and cylinder's design, Materials of construction for light, medium and heavy duty cylinders, Single acting cylinders - construction of Diaphragm cylinder, Rolling diaphragm cylinders, Gravity return and Spring return single acting cylinders, Construction of double - acting cylinders with piston rod on one side and both the sides, Telescopic cylinder, Tandem cylinder, Rodless cylinder, Cable cylinder, Sealing band Cylinder with slotted cylinder barrel, Cylinder with Magnetically Coupled Slide, Impact cylinders and Duplex cylinders, Graphic symbols of cylinders, Cylinder Seals - characteristics and classification, Static and Dynamic seals, Different types of cylinders used in cylinders, Working and applications of Air Motor.

UNIT-6

Single Actuator circuits.

Functions of the pneumatic circuits, Direct and indirect control of single-acting cylinders, Control of single-acting cylinder with OR, AND, NOT valves, Direct and indirect control of double-acting cylinders, Control of double-acting cylinders with Supply air - throttling, Exhaust air throttling, Time-dependent controls - Time delay valve NC-type, Time delay valve NO-type.

REFERENCE BOOKS

1. Fluid power with applications by Anthony Esposito - Prentice Hall of India
2. Fluid power control - NPTEL Web Course
3. Pneumatics by SRIHARI RAO
4. Pneumatic controls by FESTO
5. Fluid Power Pneumatics by ALAN H. JOHN
6. Pneumatics by FLIPPO
7. Pneumatics By TTI
8. Hydraulics & Pneumatics by RAY & RAOd
9. Fluid Power & Pneumatics by AUDEL Series

E resources/ suggested student activities

1. https://www.youtube.com/watch?v=YlmRa-9zDF8 basics
2. https://www.youtube.com/watch?v=8xd7cWvMrvE nptel
3. https://www.youtube.com/watch?v=p7kaKmwc09g practical examples
4. visit nearby JCB cranes, and tippers identify pneumatic devices and circuits, and prepare a report about their working and their location.

SUGGESTED LEARNING OUTCOMES

On successful completion of the course, the student shall be able to

1. Explain and Evaluate Hydraulics, Pneumatics and Pump

1.1 Explain the meaning of fluid power.
1.2 List the various applications of fluid power.
1.3 Explain pascals law
1.4 Differentiate between fluid power and transport systems.
1.5 Differentiate between electrical, pneumatic, and fluid power systems
1.6 List the advantages and disadvantages of fluid power.
1.7 Explain the industrial applications of fluid power.
1.8 Introduce the terms hydraulics and pneumatics.
1.9 Compare hydraulics and pneumatics
1.10 Explain the meaning of Pneumatics.
1.11 List the elements of the hydraulic power system.
1.12 List types of hydraulic oils used for power transmission
1.13 Explain the required properties of hydraulic oil
1.14 Understand hydraulic filters and working lines
1.15 Identify the type of motors used with hydraulic systems with reasons.
1.16 Classify the hydraulic pumps used in the industry.
1.17 Differentiate between positive displacement and non-positive displacement pumps.
1.18 Explain the working, construction, Advantages, and applications of external gear and internal gear pump.
1.19 Explain the working, construction, Advantages, and applications of the balanced vane and unbalanced vane pump
1.20 Explain the working, construction, Advantages, and applications of bent-axis piston pumps.
1.21 Define the mechanical, volumetric, and overall efficiency of pumps.
1.22 Differentiate between internal and external gear pumps.

2 Hydraulics actuators

2.1 Explain an actuator
2.2 Classify types of actuators – linear, rotary and semi-rotary
2.3 List different types of linear actuators
2.4 Explain the construction and working of single-acting cylinders and types- gravity return and spring return
2.5 Explain the construction and working of double-acting cylinders and types – piston rod on one side and double side
2.6 Explain the construction, working, and advantages of a telescopic cylinder
2.7 Explain the construction, working, and advantages of tandem cylinder
2.8 List types of rotary actuators
2.9 Explain the construction and working of gear, vane, and piston motors
2.10 Differentiate between a hydraulic motor and a hydraulic pump.
2.11 List various applications of hydraulic motors in fluid power.
2.12 Explain various types of efficiency terms used in hydraulic motors.
2.13 Determine the torque and power delivered by hydraulic motors

2.14 Solve problems on calculation of torque and power
2.15 List types of semi-rotary actuators Rack & pinion, parallel piston, and vane type
2.16 Explain the construction and working of Rack & pinion, parallel piston, and vane-type
2.17 Understand various lever systems -1,2 & 3 using hydraulic cylinders and their applications
2.18 Explain the importance of cylinder cushioning.

3 Directional, Pressure, and Flow control valves.

3.1 List different types of valves used in fluid power.
3.2 Classifications of directional control valves based on Construction, number of ports, number of working positions, and actuating methods
3.3 Describe the working and construction of 3/2,4/2,5/2 & 5/3 sliding spool valves and their applications.
3.4 Define valve overlap
3.5 Identify the graphic symbols for various types of direction control valves.
3.6 Explain the construction and working of DCV actuating methods.
3.7 Explain the working principle of solenoid-actuated valves.
3.8 Explain various functions of pressure-control valves like
3.9 Explain various classifications of pressure-control valves.
3.10 Describe the working and construction of pressure relief and pilot-operated pressure relief valve.
3.11 Describe the working, construction, and applications of pressure-reducing
3.12 Describe the working, construction, and applications of the unloading valve
3.13 Describe the working, construction, and applications of sequence valve
3.14 Describe the working, construction, and applications of the counterbalance valve
3.15 Understand cartridge valve
3.16 Differentiate between a pressure relief valve, a pressure-reducing valve, a sequence valve, and an unloading valve.
3.17 Identify the graphic symbols for various types of pressure-control valves.
3.18 Explain various functions of flow-control valves.
3.19 Explain various classifications of flow-control valves.
3.20 Describe the working and construction of various non-compensated flow control valves.
3.21 Differentiate between compensated and non-compensated flow-control valves.
3.22 Identify the graphic symbols for various types of flow-control valves.
3.23 Explain different applications of flow-control valves.
3.24 Know the purpose of check valve
3.25 Explain the construction and working of spring-loaded and pilot-operated check valves only
3.26 Know the purpose and applications of flow dividers

4. Hydraulic accessories, circuit design, and Analysis.

4.1 Identify various hydraulic accessories Hydraulic tanks, coolers and heaters, filters, monitoring elements, and energy storage devices (accumulators)
4.2 Know the purpose of all accessories mentioned above
4.3 Know the types of monitoring elements

4.4 Classify different types of accumulator's weight loaded, spring loaded, piston type, bladder type, and membrane type
4.5 Explain the construction and working of the above-mentioned accumulators
4.6 Identify the graphic symbols for various types of hydraulic components.
4.7 Explain various hydraulic circuits to control single-acting and double-acting cylinders.
4.8 Explain a regenerative circuit and determine the load-carrying capacities.
4.9 Describe the working of a double-pump circuit along with its advantages.
4.10 Explain the working of a sequencing circuit and a counterbalancing circuit.
4.11 Differentiate between series and parallel synchronization circuits.
4.12 Explain the fail-safe circuit with overload protection
4.13 Explain two hand safety circuit

5. Understand and explain Actuators.

5.1 Explain the meaning of Pneumatics
5.2 Describe the various properties desired of an air medium in a pneumatic system
5.3 Explain the advantages and disadvantages of compressed air
5.4 Identify and appreciate the application of pneumatic systems in various Industries
5.5 List the basic components required for a pneumatic system including F-R-L
5.6 Explain the construction and working of the filter, regulator, and lubricator
5.7 Explain the meaning of Pneumatic Actuator
5.8 Classify the various types of Pneumatic actuators. Linear, rotary, and semi-rotary
5.9 Explain the construction and working of single-acting cylinders, diaphragm, rolling diaphragm, spring return, gravity return air cylinders
5.10 Explain the construction and working of telescopic, tandem, rodless, impact, and duplex air cylinders
5.11 Explain the construction and working of double-acting cylinder, single rod, and double rod types
5.12 Explain the construction and working of rotary actuators. gear and vane-type
5.13 Explain the working and application of air motors
5.14 Explain the construction and working of cylinder cushioning
5.15 Explain the need and purpose of seals used in the Pneumatic actuators
5.16 Types of seals static, dynamic, seals material and characteristics of seals

6. Design the single Actuator Circuits.

6.1 Differentiate between pneumatic circuit and pneumatic circuit diagram
6.2 State basic rules used in the design of pneumatic circuits
6.3 Explain the memory, delay, **OR**, **AND** and **NOT** functions
6.4 Explain the direct and indirect control of single-acting cylinder
6.5 Explain the direct and indirect control of the double-acting cylinder
6.6 Explain the speed control of a single-acting cylinder
6.7 Differentiate supply and exhaust air throttling

6.8 Design pressure and time-dependent circuits

Course Outcome			Linked PO	Teaching Periods
CO1	Explain And Evaluate Hydraulic and Pneumatic Pump	R, U, A	1,2,3,7	13
CO2	Explain and differentiate Hydraulics motors	R, U, A	1,2,3,7	12
CO3	Describe the construction of various directional, Pressur,e and Flow control valves.	U, A	1,2,3,7	13
CO4	Hydraulic circuit design and Analysis.	U, A	1,2,3,7	12
CO5	Understand and explain Actuators	U, A	1,2,3,	13
CO6	Design the single Actuator Circuits	R, U, A	1,2,3,7	12
		Total Sessions		**75**

- **Legends: R = Remember U= Understand; A= Apply and above levels (Bloom's revised taxonomy)**

CO-PO Attainment Matrix:

COURSE OUTCOMES	PROGRAM OUTCOMES						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	2	2	-	-	-	1
CO2	3	2	3	-	-	-	1
CO3	3	2	3	-	-	-	
CO4	3	3	3	-	-	-	1
CO5	3	2	3	-	-	-	
CO6	3	3	3	-	-	-	1

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Lowly Addressed**.**

ME-504

MID SEM-1 EXAM
BOARD DIPLOMA EXAMINATIONS (C21)
MID SEM I, MODEL PAPER
Fluid Power Systems

Time: 1 Hours] [Total Marks: 20

Instructions: 1. Answer **ALL** questions.
2. Each question carries **ONE** mark.

1. What is the fluid transport system? 04x01=04 M
2. State two applications of fluid power in Automobiles.
3. Why is the actual torque output delivered by the hydraulic motor is less than the calculated theoretical torque?
4. What is the function of a Hydraulic cylinder?

PART-B

02X03=06M

Instructions: 1. Answer any **TWO** questions.

2. Each question carries **THREE** marks.

5. (a) Mention any three differences between the hydraulic system andthe pneumatic system.

(or)

5. (b) Define the overall efficiency of a pump. Write an expression for overall efficiency.

6. (a) State the advantages of a Hydraulic motor over an Electric motor.

(or)

5. (b) What is meant by cylinder cushioning?

PART-C

Instructions: 1. Answer any **TWO** questions. 05X02=10M

2. Each question carries **FIVE** marks.

7. (a) Explain the Classification of hydraulic pumps in fluid power systems.

(or)

7. (b) Explain the working and construction of the Vane pump.
8. (a) Explain the third-class lever system used in hydraulic cylinders.

(or)

8. (b) State the formulae for various efficiencies of a moto.?

ME-504

BOARD DIPLOMA EXAMINATIONS (C21)
MID-SEM II
MODEL PAPER
Fluid Power Systems

Time: 1 Hours] [Total Marks: 20

Instructions: 1. Answer **ALL** questions.
2. Each question carries **ONE** mark. 04x01=04 M

1. State the function of a pneumatic valve.
2. List any two applications of flow control valves.
3. Draw the graphical symbol for the cooler.
4. Draw the graphical symbol for cylinder - double acting.

PART-B

02X03=06M

Instructions: 1. Answer any **TWO** questions.

2. Each question carries **THREE** marks.

5. (a) Explain various functions of pressure-control valves.
(or)
5. (b) State the functions of the flow control valve.

6. (a) Draw the graphic symbols for the following (i) Component enclosure (ii) reservoir–vented
(iii) Reservoir - Pressurized
(or)
6. (b) What are the factors considered for designing hydraulic circuits?

PART-C

Instructions: 1. Answer any **TWO** questions. 05X02=10M
2. Each question carries **FIVE** marks.

7. (a) Explain the ball-type check valve with a neat sketch.
(or)
7. (b) Explain the working principle of a solenoid-actuated valve.
8. (a) Explain the protection against overload circuit

(or)
8. (b) Describe the working of a pump-unloading circuit using a circuit diagram

ME-504

BOARD DIPLOMA EXAMINATIONS (C18)
SEE-MODEL PAPER
DME– V SEMESTER EXAMINATION
Fluid Power Systems

Time: 2 Hours] [Total Marks: 40

PART-A

08X01=08

Instructions: 1. Answer **ALL** questions.

2. Each question carries **ONE** mark.

1. Define hydraulic rotary actuator.
2. State the function of a check valve
3. List the types of pneumatic actuators
4. Write the classification of hydraulic motors.
5. State the different power transmission systems.
6. What is a dynamic seal?
7. State the basic rules used in the design of pneumatics.
8. State the function of pneumatic circuits.

PART-B

04X03=12

Instructions: 1. Answer any **FOUR** questions.

2. Each question carries **THREE** marks.

9. (a) List out the types of hydraulic cylinders.

(or)

9. (b) Write a short note on free air and standard air.

10. (a) Explain briefly the functions of the direction control valve.

(or)

10. (b) Why Exhaust air throttling is used for speed control of the double-acting cylinder?

11. (a) State the rules followed in the selection of a working medium in a fluid power system.

(or)

11. (b) Write the advantages of the pneumatic system

12. (a) State the rules used in the design of Pneumatic circuits.

(or)

12. (b) How does a **3/2-way** valve work?

PART-C

04X5=20

Instructions: 1. Answer any **FOUR** questions.

2. Each question carries **FIVE** marks.

13. (a) Explain the screw pump with a neat sketch.

(or)

13. (b) What are the basic components of the Pneumatic system? Explain their function

14. (a) Describe the working of the Double-Pump hydraulic system using a circuit diagram.

(or)

14. (b) Explain the Control of a single-acting cylinder with a "NOT" valve.

15. (a) Write briefly about the advantages and disadvantages of compressed air.

(or)

15. (b) State the specific applications of pneumatic systems in various industries.

16. (a) Explain the direct control of the double-acting cylinder

(or)

16. (b) Explain Exhaust air throttling.

AU-515A-AUTOMOBILE ENGINEERING

Course Title:	Automobile Engineering	Course Code:	AU-515A
Semester:	V	Course group :	Elective
Teaching Scheme(L:T:P):	4:1:0	Credits:	2.5
Methodolgy :	Lecture + Assignment	Total contact periods:	75
CIE:	60 Marks	SEE:	40 Marks

Prerequisites: Basic knowledge of Science, Workshop technology, Thermal engineering, theory of Machines.

COURSE OUTCOMES

On successful completion of the course, the students will be able to

Course Outcomes	
CO1	Demonstrate the concept of the basic structure of an Automobile Chassis and Frame
CO2	Aware of the working principle of clutch and Apply the concept of the Transmission system to an Automobile
CO3	Describe the arrangement, and working of the Propeller Shaft and rear axle.
CO4	Explain the detailed working of the front axle and steering system
CO5	Demonstrate the working of wheels and suspension system and compare the characteristics of various tyres.
CO6	Demonstrate the classification of brakes and the working principle of the braking system

Blue Print of Marks for SEE:

<table>
<tr><th colspan="2" rowspan="2">Units</th><th rowspan="2">No of periods</th><th colspan="3">Questions to be set for SEE</th><th rowspan="2">Remarks</th></tr>
<tr><th>R</th><th>U</th><th>A</th></tr>
<tr><td rowspan="2">Part-A</td><td>1.Automobile Chassis and Frame</td><td>10</td><td rowspan="6">Q4</td><td rowspan="2">Q1</td><td rowspan="2">Q9(a)</td><td rowspan="2">Q13(a)</td><td rowspan="2"></td></tr>
<tr><td>2. Clutch and Transmission system</td><td>13</td></tr>
<tr><td rowspan="2">Part-B</td><td>3. Propeller Shaft and rear axle</td><td>12</td><td rowspan="2">Q2</td><td rowspan="2">Q10(a)</td><td rowspan="2">Q14(a)</td><td rowspan="2"></td></tr>
<tr><td>4 Front Axle and Steering</td><td>13</td></tr>
<tr><td rowspan="2">Part-C</td><td>5. Suspension, wheels and tyres</td><td>14</td><td rowspan="2">Q3</td><td>Q5
Q6</td><td>Q9(b)
Q11(a)
Q11(b)</td><td>Q13(b)
Q15(a)
Q15(b)</td><td rowspan="2"></td></tr>
<tr><td>6.Brakes</td><td>13</td><td>Q7
Q8</td><td>Q10(b)
Q12(a)
Q12(b)</td><td>Q14(b)
Q16(a)
Q16(b)</td></tr>
<tr><td colspan="2">TOTAL</td><td>75</td><td colspan="2">08</td><td>08</td><td>08</td><td></td></tr>
</table>

COURSE CONTENT

UNIT-1 **No of Periods (L-8,T-2)**

Automobile Chassis and Frame

Automobile components - Basic structure - transmission system, the auxiliaries, the controls, and the superstructure.

Chassis -various types of Chassis, It's construction. The functions of the frame- The loads on frame- frame construction, Materials for frame, Defects in frame- frameless construction.

UNIT-2 **No of Periods (L-12,T-1)**

Clutch and Transmission system

Requirements of Clutch, Description of Clutch components - Types of Clutches(friction and fluid clutches only), Mechanical operation of Clutch, Principle of friction clutch - description and working of dry friction clutches, Working of Hydraulically operated single plate clutch.

Transmission system- Function of components, the concept of total resistance to the vehicle motion, Tractive effort, Necessity of transmission, Working of gear boxes-Selector mechanism with the gear lever, Lubrication of the gearbox.

UNIT-3

No of Periods: (L-11, T-1)

Propeller Shaft and rear axle

Functions of the propeller shaft, Construction of the Propeller shaft, Universal joints, The function and operation of a Differential, Arrangement of a live rear axle, Loads on the rear axle, Different methods of supporting rear axle shafts, Difference between semi-floating and full floating rear axle.

UNIT-4

No of Periods: (L-12, T-1)

Front Axle and Steering system

Axle and its Function – Stub axle, Its types, Description of Elliot, Reverse Elliot, Lamoine - Reverse Lamoine -Front wheel stub axle assembly, Steering system- Functions & Requirement of the steering system. Construction and working of steering linkage – the principle of correct steering (simple equation), Steering geometry, Ackerman steering mechanism-Power steering.

UNIT-5 **No of Periods: (L-12, T-2)**

Suspension, wheels, and tyres:

Suspension- Elements of suspension, Different types of suspension springs- Leaf Springs-Helical Springs and its construction, Construction and working of McPherson and wishbone suspension –Air Suspension, Construction and working of Telescopic shock absorbers.

Automobile wheels, their construction and working, Requirements of wheels - Construction, working and comparison of radial, cross-ply and tubed, tubeless tyre - Tyre specifications-Factors affecting tyre life-Wheel Alignment and Balancing.

UNIT-6 **No of Periods: (L-11, T-2)**

Brakes

Brake- Types of Brakes, transfer of weight during braking operation, wheel skidding and techniques to prevent wheel skidding-Factors influencing braking effect, Mechanical shoe brake, Parking Brake, Hydraulically operated four wheel brake and its working, Air brake system and explain its working in detail. Internal expanding brake - Disc brake- Anti-lock braking system(ABS), Regenerative Brakes System(RBS).

REFERENCE BOOKS

1. Automobile Engineering Vol I, II, Kirpal Singh, Standard Publishers Distributors, Delhi. 2012.
2. Automobile Mechanics, A.K. Babu, S.C. Sharma, Khanna Publications, New Delhi
3. Automobile Engineering R.B.Guptha –
4. Automobile Mechanics William Crouse Tata Mcgraw hill
5. Automotive Mechanics Joseph Hitner
6. Automotive Engineering, Jain and Asthana, Tata McGraw Hill.
7. Automotive Engineering-G.B.S Narang

8. Automobile Engineering- Kirpalsingh
9. Automobile Engineering- Rajput
10. The motor vehicle- Newton Steeds & Garret
11. Automotive Chassis- P.M. Heldt.

SUGGESTED RESOURCES

1. Automatic Transmission System
https://www.youtube.com/watch?v=u_y1S8C0Hmc
2. Rack & Pinion Steering mechanism.
https://www.youtube.com/watch?v=_L41jg9h-S0
3. Anti-lock braking system(ABS)
https://www.youtube.com/watch?v=ru4JIZ-x8yo
4. McPherson & wishbone.
https://www.youtube.com/watch?v=oZz7RD7KRI0
5. Wheel Alignment and Balancing.
https://www.youtube.com/watch?v=7d2K_mKgsZ0
6. hydraulically operated four-wheel brake system
https://www.youtube.com/watch?v=82qBBJ8iwcc

SUGGESTED STUDENT ACTIVITIES

1. Prepare a list of various major automobile manufacturers of Two-wheelers and four-wheelers in India, along with their specifications.
2. Prepare a report on the Top 10 Car/MUV/2W/Heavy vehicle Manufacturers in India & their sales in last 2 Years.
3. Collect the detailed specifications on the Top 5 models of cars manufactured in India
4. Download technical specifications/ catalogs, videos, or any other suitable presentations on Automobile engines used in four-wheelers
5. Download technical specifications/ catalogs, videos, or any other suitable presentations on Automobile tyres/Power steering/Suspension system
6. Visit to a four- wheeler service station & any automobile manufacturing unit. Prepare handwritten reports on aspects they observed in a service station

SUGGESTED LEARNING OUTCOMES

Upon completion of the course, the student shall be able to

1.0 Introduction to the basic structure of an automobile

1.1 Explain various components of an automobile.
1.2 Define the basic structure, the power plant, the transmission system, the auxiliaries, the controls, and the superstructure of an automobile.
1.3 List types of Chassis construction.
1.4 Define functions of frame.

1.5 Define loads on the frame.
1.6 Explain Frame construction with a neat sketch.
1.7 Write various materials for frames
1.8 Explain Subframes and defects in frames.
1.9 Explain Frameless construction with a sketch.
1.10 Explain Engine construction with a neat sketch.
1.11 Explanation of stationary and moving parts of the engine

2.0 Clutch and Transmission

2.1 Explain the Functions of Clutches.
2.2 Know the Requirements of Clutch.
2.3 Give a Brief description of the components of the Clutch, clutch plate-clutch facing- pressure plate-springs-Bearings.
2.4 Know the Mechanical operation of the clutch.
2.5 Illustrate the Main types of clutches (Friction clutch and fluid clutch only).
2.6 Understand the Principle of friction clutches - Coefficient of friction, axial pressure (w), and mean radius of contact surfaces(R).
2.7 Give Description and working of dry friction clutches-Single plate, multi-plate.
2.8 Formulas for Torque transmission for uniform pressure and uniform wear criterion (without derivation)
2.9 Simple problems on a single plate and multi-plate friction clutches.
2.10 Understand the Working of hydraulically operated single plate clutch
2.11 Functions of the transmission system.
2.12 Explain the Concept of total resistance to the vehicle motion-Tractive effort-necessity of transmission.
2.13 State Working of sliding mesh-constant mesh-Synchromesh gearboxes.
2.14 State Working of selector mechanism with gear lever on top of the transmission case
2.15 Explain the Lubrication of the gearbox.

3.0 Propeller Shaft and rear axle

3.1 Explain the functions of the propeller shaft.
3.2 Understand the construction of the propeller shaft with a neat sketch.
3.3 Explain various universal joints in automobiles.
3.4 Analyse the function and operation of the differential in an automobile.
3.5 Understand the general arrangement of a live rear axle.
3.6 Give different loads on the rear axle.
3.7 Explain Different methods of supporting rear axle shafts with a sketch.
3.8 Give the difference between semi-floating and fully floating rear axle

4.0 Front Axle and Steering

4.1 Define front axle.
4.2 Explain Stub axle-ELLIOT-Reversed ELLIOT-LAMOINE-Reversed LAMOINE-brief description.

4.3 Description of front wheel stub axle assembly.
4.4 Explain Factors influencing the wheel alignment.
4.5 Understand Factors pertaining to wheels -Balance of wheels-Inflation of tyres - Brake adjustment-Concept of Steering geometry - Camber - Kingpin inclination - Combined angle - castor - Toe-in & Toe-out and their effects
4.6 Explain Steering linkage - the principle of correct steering angle (without mathematical analysis) simple equation.
4.7 Give details of the Ackerman steering mechanism.
4.8 Understand the concept of cornering force-self-righting torque.
4.9 Understand the concept of under steering & over steering.
4.10 Understand the concept of Rack & Pinion Steering mechanism-Power steering

5.0 Suspension systems wheels and tyres

5.1 Explain the Suspension system.
5.2 Know the Need for a good suspension system.
5.3 List elements of the suspension system.
5.4 Explain Leaf Springs.
5.5 Explain Helical Springs.
5.6 Explain the Construction & working of McPherson & wishbone.
5.7 Explain the Construction & working of Telescopic shock absorbers.
5.8 List types of Automobile wheels.
5.9 Explain the construction & working of different Automobile wheels.
5.10 Explain the essential requirements of wheels.
5.11 Explain the Construction, working & comparison of a radial, cross-ply, and tubed, tubeless tyre.
5.12 Give Tyre specifications.
5.13 Explain Factors affecting tyre life.
5.14 Explain Wheel Alignment and Balancing.

6.0 Brakes

6.1 Know the requirements of an automobile brake.
6.2 Understand the transfer of weight during braking operation.
6.3 Explain wheel skidding and describe techniques to prevent wheel skidding.
6.4 Explain various factors influencing the braking effect.
6.5 Give Classification of brakes.
6.6 Understand mechanical shoe brakes with a neat sketch.
6.7 Explain the layout of the hydraulically operated four-wheel brake system with a simple diagram and explain its working in detail.
6.8 Explain the schematic diagram showing the layout of the complete air brake system and explain the working of its main units in detail.
6.9 Explain the working of disc brakes
6.10 Explain about ABS
6.11 Explain the working of the Regenerative Braking System.

Legends: R = Remember; U= Understand; A= Apply and above levels (Bloom's revised taxonomy)

CO1	Demonstrate the concept of basic structure of an Automobile Chassis and Frame	R, U	1,5, 7	10
CO2	Aware the working principle of clutch and Apply the concept of Transmission system to an Automobile	R, U, A	1, 5, 7	13
CO3	Describe the arrangement and working of Propeller Shaft and rear axle.	R,U	1,5, 7	12
CO4	Explain the detail working of front axle and steering system	R,U, A	1,5, 7	13
CO5	Demonstrate the working of wheels, Suspension system and compare the characteristics of various types of tyres.	R,U, A	1, 5, 7	14
CO6	Demonstrate the classification of brakes and the details working principle of braking system	R, U, A	1,5, 7	13
			Total Periods	**75**

CO-PO Attainment Matrix:

COURSE OUTCOMES	**PROGRAM OUTCOMES**						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2	0	0	0	2	0	3
CO2	3	0	0	0	3	0	3
CO3	3	0	0	0	3	0	3
CO4	3	0	0	0	3	0	3
CO5	3	0	0	0	2	0	3
CO6	3	0	0	0	3	0	3

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Lowly Addressed**.**

Legend	Remembering (R)	1 Mark
	Understanding (U)	3 Marks
	Application (A)	5 Marks

MID SEM - I
MODEL PAPER
AU-515A- AUTOMOBILE ENGINEERING

Time: 1 Hour **Max. Marks:** 20

PART-A 4 X 1 = 4

Instructions: 1. Answer **ALL** questions.
2. Each question carries **ONE** mark.

1. Define piston.
2. List two functions of piston rings
3. What are the requirements of Clutch
4. What is the purpose of Clutch

PART-B 2 X 3 = 6

Instructions: 1. Answer **ALL** questions.
2. Each question carries **THREE** marks.

5. (a) List various components of an automobile.

OR

5 .(b) What are the different loads on the frame?

6. (a) List different types of gearboxes.

OR

6(b) What are the functions of the transmission system?

PART-C 2 X 5 = 10

Instructions: 1. Answer **ALL** questions.
2. Each question carries **FIVE** marks.

(7(a) Explain Engine construction with a neat sketch

OR

7(b) Explanation of stationary and moving parts of the engine

.

8(a) Explain the Working of hydraulically operated single plate clutch

OR

8(b) Explain the working of the Sliding mesh Gearbox with a neat sketch

MID-SEM - II
MODEL PAPER
AU-515A- AUTOMOBILE ENGINEERING

Time: 1 Hour **Max. Marks:** 20

PART-A 4 X 1 = 4

Instructions: 1. Answer **ALL** questions.
2. Each question carries **ONE** mark.

1. What is the function of a propeller shaft?
2. What is differential?
3. Define front axle.
4. Write the correct steering angle.

PART-B 2 X 3 = 6

Instructions: 1. Answer **ALL** questions.
2. Each question carries **THREE** marks.

5. (a) Give different loads on the rear axle.

OR

5(b) what are Various universal joints in automobiles

6(a) List the functions of steering mechanism

OR

6(b) What are the requirements of the steering mechanism

PART-C 2 X 5 = 10

Instructions: 1. Answer **ALL** questions.
2. Each question carries **FIVE** marks.

7. (a) Explain Different methods of supporting rear axle shafts with a sketch.

. OR

7(b) Give The difference between semi-floating and fully floating rear axle

8(a) Explain the Construction and working of the Power Steering mechanism with a neat sketch.

OR

8(b) Explain the Ackerman steering mechanism.

BOARD DIPLOMA EXAMINATION, (C-21)
SEE-MODEL PAPER
DME– V SEMESTER EXAMINATION
AU-515A- AUTOMOBILE ENGINEERING

Time: 2 Hours **Max. Marks:** 40

PART-A 8 X 1 = 8

Instructions: 1. Answer **ALL** questions.
2. Each question carries **ONE** mark.

1. List the different types of gearboxes.
2. Define Kingpin inclination.
3. List the elements of the suspension system.
4. List the types of Automobile wheels.
5. List the factors affecting the tyre life.
6. What is the Need for a good suspension system?
7. What are the requirements of an automobile brake?
8. What is wheel skidding?

PART-B 4 X 3 = 12

Instructions: 1. Answer **ALL** questions.
2. Each question carries **THREE** marks.

9(a). what are the different types of Chassis construction

OR

9(b) . Explain tubed tyres.

10(a). Explain the construction of the propeller shaft with a neat sketch

OR

10(b). list the types of Excavators.

11 (a) Explain telescopic shock absorbers

OR

11 (b) Explain the elements of the suspension system.

12(a). Give Classification of brakes.

OR

12(b). Explain various factors influencing the braking effect.

.

PART-C 4 X 5 = 20

Instructions: 1. Answer **ALL** questions.
2. Each question carries **FIVE** marks.

13 (a). Explain various components of an automobile.

OR

13 (b). explain the wishbone suspension system.

14 (a)Explain the working of the Rack & Pinion Steering mechanism

OR

14 (b) Explain the Anti-lock braking system.

15 (a)Explain the McPherson suspension system..

OR

15 (b) Explain wheel alignment and balancing in a vehicle.

16 (a). Explain mechanical shoe brake with a neat sketch.

OR

16 (b) Explain wheel skidding and describe techniques to prevent wheel skidding.

EE-505B ELECTRIC VEHICLES

Course Title:	**Electric Vehicles**	Course Code	**EE-505B**
Semester	**V Semester**	Course Group	**Elective**
Teaching Scheme in Periods (L:T:P)	**4:1:0**	Credits	**2.5**
Methodology	**Lecture + Tutorials**	Total Contact Periods	**75**
CIE	**60 Marks**	SEE	**40 Marks**

Prerequisites:
Basic knowledge of Electrical machines, Electric circuit analysis, Power electronic converters, Battery technology, Drive trains, I.C. Engines, and Working principles of automobiles.

Course Outcomes
Upon Successful completion of the course, the student will be able to

CO1 :	Outline the layout of an automobile and the functional parts of an automobile.
CO2 :	Summarize the architecture of the Electric, Hybrid Vehicles and the function of their components.
CO3 :	Illustrate the constructional details of various power sources of electric vehicles and Battery management systems.
CO4 :	Explain the concepts of battery charging and Indian standards for E.V. charging.
CO5 :	Interpret the working of various E.V. motors, drives, and drive controls.
CO6	Summarise the concepts of Renewable energy integration of a charging station, Recycling, and disposal of an Electric vehicle battery and to trouble shoot an electric vehicle.

Course Contents:

UNIT-1: Introduction to Vehicle and its sub Systems **Periods: 10**

Definition of an Automobile – General layout of an automobile – Axle and types of axles – Two-wheel drive and four-wheel drive – Frame and Chassis – Introduction to Functional systems of an automobile: Working of 4-stroke I.C.Engines, Cooling system, Lubrication System, Working principle of a friction clutch, Construction and working of single plate clutch and Diaphragm Clutch, Need of gearbox, Working of constant mesh gearbox and synchromesh gearboxes, Propeller shaft and Universal joints, Final drive, Differential, Wheels and Tyres, Steering system, Suspension system, Braking system.

UNIT-2: Introduction to Electric and Hybrid Vehicles **Periods: 10**

Introduction to Electric Vehicle(EV) – Hybrid Electric vehicle (HEV) – Plug-in Hybrid Electric vehicle (PHEV) - Types of Electric vehicles based on drive train configuration – Types of HEV series, parallel, series-parallel and Complex - Fuel cell vehicles -Differences between EV and conventional vehicles - Differences between complete EV and Hybrid vehicles - Differences between series hybrid and parallel HEV - Differentiate between a mild hybrid and full hybrid - Benefits of EV including environmental impacts - Types of Transmission: Single speed transmission, Multispeed transmission and Continuously Variable Transmission (CVT) - Single and multi-motor drives in electric vehicles - Operating modes of power flow control in a Series HEV. Parallel HEV, ICE dominated power flow control modes in Series Parallel HEV - Mechanical coupling in Parallel HEV - Types of mechanical coupling – Dual Clutch transmission- Difference between 2WD, 4WD, and AWD.

Unit-3: Battery and Battery Management System **Periods: 10**

Introduction to energy storage devices in EV and HEV- main types of batteries used in EVs- Definition of different battery parameters - Lead Acid Battery – Nickel based batteries – Lithium based batteries - Definition of different battery parameters - Effect of Temperature on battery performance - C-Rate parameter - Hybridization of different energy storage devices -Difference between Cell monitoring Controller and battery monitoring Controller - Protective measures for EV batteries - Fuel Cell - Types of fuel cells - Super Capacitor - Super Flywheel based energy storage and it's analysis- EV battery and battery management systems.

UNIT-4: Charging Station and Standards **Periods: 10**

Definition and purpose of charging station - Understand AC and DC Charging -Difference between level 1, level 2, and level 3 Chargers - Domestic and Public charging equipment - EV acceptance rate - Onboard and Off-board charging - Power factor correction in an On-Board Charger (OBC) - Types of Level 3 Chargers – Bi-directional charging - Type-1, Type-2 and Type-3 connector - CHAdeMO connector - Combined charging system(CCS) Combo-1 and Combo-2 connectors - Charging time and Charging cost - Peak shaving - Difference between charging station (EVCS) and charging point (EVSE) - Open Charge Point Protocol (OCPP) - Electric Vehicle Supply Equipment (EVSE) - Battery swapping - Wireless charging- Indian Standards for AC and DC Charging.

UNIT-5: EV Motors, Drives, and Drive Control **Periods: 15**

Various components of EV and their purpose - Introduce Electric motor as Propulsion unit - Types of Electric motors used in EV- Switching devices – MOSFET - IGBT- Advantages of DC motors over AC - construction and working of BLDC Motors - Induction motor - Permanent magnet Synchronous motor, Switched reluctance motor and their Controllers and Drives.

UNIT-6 EVs and renewable energy (RE) integration, Troubleshooting Periods: 15

Scheduling of EVs for increased RE generation uptake - RE-based EV charging stations Correlation between EV charging and RE integration - Coordinated operation of EVs and distributed generation - Cost comparison of RE-based EV charging with other alternatives Maintenance, repairing and services Troubleshooting faults in different EV components (Motor, drive train, battery etc.) - Repairing and rectifying faults in EV motor and components - EV charging device repairing - Battery disposal & Recycling.

Reference Books:

1 A Text Book on Modern EV,HEV, and Fuel cell vehicles by Mehardad, Eshani, YiminGao

2 Handbook on EV charging Infrastructure Implementation by NITI Ayog, Govt Of India

3 NEPTEL Notes on Introduction to EV & HEV

4 Electric Vehicle trends - Electrical Installation Guide (electrical-installation.org)

5 Electric Vehicles Integrated with Renewable Energy Sources for Sustainable Mobility https://www.intechopen.com

6 (PDF) A REVIEW ON RENEWABLE ENERGY INTEGRATION FOR ELECTRIC VEHICLES(researchgate.net)

Suggested E-learning references:

1. https://nptel.ac.in/courses/108/106/108106170/
2. https://en.wikipedia.org/wiki/Category:Heavy_equipment
3. How does an Electric Car work? | Tesla Model S: https://www.youtube.com/watch?v=3SAxXUIre28
4. Tesla Model : https://www.youtube.com/watch?v=esUb7Zy5Oio
5. Toyota Hybrid System: https://www.youtube.com/watch?v=jNuixuVhc5E
6. Honda Motor Hybrid System Explained: https://www.youtube.com/watch?v=-P_VChtMGK8
7. Honda Hybrid E-Drive https://www.youtube.com/watch?v=QLUIExAnNcE
8. Audi e-tron Motor Production: https://www.youtube.com/watch?v=uWBEPEspbWI
9. BMW Battery Cells Production Assembly Line: https://www.youtube.com/watch?v=xvaQMTcckSg
10. How Tesla Builds Cars So Fast: https://www.youtube.com/watch?v=KqXi6EkCdpQ

Suggested Learning Outcomes:

Upon completion of the course, the student shall be able to

CO1: Outline the layout of an automobile and the functional parts of an automobile.

1.0 Define an Automobile
1.1 Draw the general layout of an automobile
1.2 Define an axle
1.3 List the types of Axle
1.4 Differentiate between a live axle and a dead axle
1.5 Identify the difference between Two-wheel drive and four-wheel drive
1.6 Define a Frame
1.7 Define a Chassis
1.8 Differentiate between a frame and a chassis
1.9 List the Functional systems of an automobile
1.10 State the function of each functional component of an automobile
1.11 Explain the working of 4-stroke I.C Engines
1.12 List the types of cooling systems
1.13 Explain the working of the liquid cooling system.
1.14 List the types of lubricating systems
1.15 Explain the working of the wet sump lubricating system.
1.16 Explain the working principle of a friction clutch
1.17 Illustrate the construction and working of single plate clutch
1.18 Summarise the working of the diaphragm spring clutch
1.19 State the need of a gearbox
1.20 Interpret the working of constant mesh gearboxes and synchromesh gearboxes
1.21 State the function of a Propeller shaft
1.22 Explain the need for Universal joints
1.23 State the function of the Final drive
1.24 Interpret the need of a Differential in an automobile
1.25 State the role of wheels in an automobile
1.26 List the types of tyres used in an automobile
1.27 State the function of the Steering system in an automobile
1.28 Explain the need of a Suspension system
1.29 List the types of suspension systems used in automobiles
1.30 State the need of a brake for an automobile
1.31 State the working principle of the braking system.
1.32 Draw the layout of a hydraulic braking system.
1.33 Explain the construction and working of a hydraulic braking system.

C02 - Summarize the architecture of the Electric, Hybrid Vehicles and the function of their components.

2.0 Define an Electric Vehicle (EV)
2.1 Define a Hybrid Electric vehicle (HEV)
2.2 Define a Plug-in Hybrid Electric vehicle (PHEV)
2.3 List the types of Electric vehicles based on drive train configuration
2.4 Draw the layout of HEV series, parallel, series-parallel, and Complex
2.5 Define a Fuel cell vehicle

2.6 State the differences between EV and conventional vehicles
2.7 List the differences between complete EV and Hybrid vehicles
2.8 Enumerate the differences between series hybrid and parallel HEV
2.9 Differentiate between a mild hybrid and a full hybrid
2.10 State the benefits of EVs including environmental impacts
2.11 Draw the layout of single-speed transmission in Electric vehicles
2.12 Explain the concept of single-speed transmission in Electric vehicles
2.13 Draw the layout of multi-speed transmission in Electric vehicles
2.14 Explain the concept of multi-speed transmission in Electric vehicles
2.15 Draw the layout of CVT in Electric vehicles
2.16 Explain the concept of CVT in Electric vehicles
2.17 Explain the Single and multi-motor drives in electric vehicles
2.18 Illustrate the operating modes of power flow control in a Series HEV. Parallel HEV, ICE dominated power flow control modes in a Series-Parallel HEV
2.19 State the use of mechanical coupling in Parallel HEV
2.20 Explain the types of mechanical coupling in parallel HEV
2.21 Summarise the concept of dual-clutch transmission
2.22 State the advantages and limitations of 2WD, 4WD and AWD.

C03 - Illustrate the constructional details of various power sources of electric vehicles and Battery management systems.

3.1 List the various components of EVs like
- 3.1i Traction battery pack.
- 3.1ii DC-DC Converter.
- 3.1iii Electric motor.
- 3.1iv Power inverter.
- 3.1v Charge Port.
- 3.1vi Onboard charger.
- 3.1vii Controller.

3.2 Know the purpose of each component.
3.3 Introduce Electric motor as Propulsion unit.
3.4 List various types of Electric motors both AC/DC.
3.5 List the advantages of DC motors over AC.
3.6 Explain the construction and working of the Induction motor.
3.7 Explain the construction and working of the Permanent magnet motor.
3.8 Describe the construction and working of the Switched reluctance motor.
3.9 List the various energy storage devices like Batteries, Fuel cells, Supercapacitors, and super fly wheels.
3.10 Outline the battery terminology like
- 3.10i Depth of Discharge.
- 3.10ii Daily Depth of Discharge.
- 3.10iii Battery State of Charge (BSOC).

3.10iv Self-discharge rate.
3.10v Charge equalization.
3.10vi State of health.
3.10vii Calendar life.
3.10viii Charge cycle.
3.10ix Cycle life.
3.10x Battery capacity.
3.10xi Internal resistance.

3.11 Explain the effect of Temperature on battery performance.
3.12 Define the term C-Rate parameter.
3.13 List three main types of batteries used in EVs.
3.14 Name three types of cathode materials in a lithium-ion battery.
3.15 State the advantages/Merits of Lithium batteries as an energy source for EVs.
3.16 State the need and concept of Hybridization of various energy sources.
3.17 List five types of fuel cells.
3.18 Describe the main components of a battery management system.
3.19 Differentiate between Cell monitoring Controller and battery monitoring Controller.
3.20 Name five protective measures for EV batteries.

CO4 - Explain the concepts of battery charging and Indian standards for E.V. charging.

4.1 Definition and purpose of charging station
4.2 Identify the difference between AC and DC Charging
4.3 Differentiate between level 1, level 2, and level 3 Chargers.
4.4 Summarize the domestic and Public charging equipment
4.5 Define the term EV acceptance rate.
4.6 Differentiate between on-board and off-board charging.
4.7 Explain the purpose of power factor correction in an On-Board Charger (OBC)
4.8 Comprehend Indian Standards for AC and DC Charging (ex. IS17017).
4.9 Describe the principle of bidirectional charging.
4.10 List the five basic types of EV connectors.
4.11 Identify the types of connectors to plug the charging cable to the vehicle inlet like Type-1, type-2, and type-3 connectors.
4.12 Identify the CHAdeMO connector, Combined charging system (CCS) Combo-1 and combo-2 connectors
4.13 Calculate charging time and charging cost.
4.14 Define the term peak shaving.
4.15 Identify the difference between a charging station (EVCS) and a charging point (EVSE)
4.16 Explain the purpose of Open Charge Point Protocol (OCPP)
4.17 Identify the various parts and working of Electric Vehicle Supply Equipment (EVSE)
4.18 State the difference between manual and automated battery swapping.

4.19 List the merits and demerits of battery swapping.

4.20 Explain the concept of Wireless charging.

CO5 - Interpret the working of various E.V motors, drives, and drive controls.

5.1 List the various components of EV and state their purpose

5.2 State the role of the Electric motor as a Propulsion unit

5.3 List the types of Electric motors used in EV

5.4 Name the various Switching devices used in Electric vehicles

5.5 Explain the role of MOSFET – IGBT in the drive control of Electric vehicles

5.6 Advantages of DC motors over AC motors

5.7 Explain the construction and working of BLDC Motors, Induction motors, Permanent magnet Synchronous motors, and Switched reluctance motors.

5.8 Explain the working of Electronic Controllers and Drives.

C06 - Summarise the concepts of Renewable energy integration of a charging station, Recycling, and disposal of an Electric vehicle battery and to trouble shoot an electric vehicle.

6.1 List and understand various types of renewable energy sources.

6.2 Define the term smart grid.

6.3 State the need for EV integration with renewable energy.

6.4 List the advantages of EV integration with renewable energy.

6.5 Identify the safety aspects of EVs.

6.6 Summarise the service and maintenance schedules of EVs.

6.7 Identify the challenges in EV integration with renewable energy.

6.8 Explain EV integration with Wind energy.

6.9 Explain EV integration with solar energy.

6.10 State the term EV coordination.

6.11 Identify the battery faults like

a. Overcharge and Over-discharge
b. Overheating and undercooling
c. Short circuit or open circuit of the inner cell

6.12 State the steps to identify a dead battery

6.13 Explain the procedure to dispose of a dead battery disposal.

6.14 Illustrate the methods adopted for recycling a dead battery.

6.15 Identify the drive motor faults.

6.16 State the procedure for the identification of software problems.

6.17 State the method to use OBD (On-board diagnostics) and scanning tools for OBD.

6.18 Explain the methods available for Remote diagnostics.

6.19 Explain the process to identify various Power electronics faults.

CO-PO Matrix

CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1
CO 1	Outline the layout of an automobile and the functional parts of an automobile.	3	2	1	-	-	-	2	2
CO 2	Summarize the architecture of the Electric, Hybrid Vehicles and the function of their components.	2	1	-	-	-	-	2	1
CO 3	Illustrate the constructional details of various power sources of electric vehicles and battery management systems.	3	2	-	-	1	1	2	-
CO 4	Explain the concepts of battery charging and Indian standards for E.V. charging.	3	2	1	-	3	1	3	-
CO 5	Interpret the working of various E.V. motors, drives, and drive controls.	3	2	1	-	1	1	2	-
CO 6	Summarise the concepts of Renewable energy integration of a charging station, Recycling, and disposal of an Electric vehicle battery and to trouble shoot an electric vehicle.	1	1	1	-	2	-	2	3

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Lowly Addressed**.**

OVERVIEW OF CONTINUOUS INTERNAL EVALUATION

Mid Semester Examination-1 **Max.Marks: 20**

S.No	Unit	R	U	A	Remarks
1	Unit-I	1, 2	5(a)	7(a)	
			5(b)	7(b)	
2	Unit-II	3, 4	6(a)	8(a)	
			6(b)	8(b)	
Total Questions		4	4	4	

Mid Semester Examination-2 **Max.Marks: 20**

S.No	Unit	R	U	A	Remarks
1	Unit-III	1, 2	5(a)	7(a)	
			5(b)	7(b)	
2	Unit-IV	3, 4	6(a)	8(a)	
			6(b)	8(b)	
Total Questions		4	4	4	

Internal Assessment **Max.Marks: 20**

Type of test	Unit	Marks allotted	Remarks
Slip Test 1	1 and 2	5	2 Essay Questions out of 3 Questions
Slip Test 2	3 and 4	5	2 Essay Questions out of 3 Questions
Assignment	Anyone Unit	5	Questions will be issued to the individual or to a group at the discretion of the faculty.
Seminar		5	Any topic approved by the faculty

Blue Print of Marks for SEE:

Unit No	Unit Name	Periods	Questions to be set for SEE			
			R		U	A
1	Introduction to Vehicle and it's sub Systems	10	Q4	Q1	Q9(a)	Q13(a)
2	Introduction to Electric and Hybrid Vehicles	15				
3	Battery and Battery Management Systems.	10		Q2	Q10(a)	Q14(a)
4	Charging Station and Standards	15				
5	E.V Motors, Drives and Drive Control	10		Q3 Q5, Q6	Q9(b), Q11(a), Q11(b)	Q13(b), Q15(a), Q15(b)
6	EV's and Renewable energy integration, Troubleshooting	15		Q3 Q7, Q8	Q10(b), Q12(a), Q12(b)	Q14(b), Q16(a), Q16(b)
Total		**75**	**8**		**8**	**8**

STATE BOARD OF TECHNICAL EDUCATION &TRAINING, TELANGANA

EE-505B, ELECTRIC VEHICLES

MID-SEM -I MODEL PAPER

TIME: 60 min **TOTAL MARKS: 20**

Important Note: Wherever any question has a choice, marks will be allotted only to the first attempted question. No marks will be allotted for extra questions answered.

PART – A **Marks: 4Q X 1= 04**

Instructions: (1) Answer all questions. (2) Each question carries One mark.

1. Define an Automobile.
2. Define a Chassis.
3. Define EV?
4 Define a Fuel Cell Vehicle.

PART – B **Marks: 2Q X 3= 06**

Instructions:(1) Answer all questions.(2) Each question carries Three marks.

5(a) List the Functional systems of an automobile.

----OR----

5(b) List the Types of Cooling systems.

6(a) List the types of Electric vehicles based on drive train configuration.

----OR----

6(b) State the use of mechanical coupling in Parallel HEV.

PART – C **Marks: 2Q X 5= 10**

Instructions: (1) Answer all questions. (2) Each question carries Five marks.

7(a) State the function of the Steering system in an automobile

----OR----

7(b) Draw the layout of a hydraulic braking system.

8(a) Draw the layout of HEV series, parallel, series-parallel, and Complex

----OR----

8(b) Differentiate between a mild hybrid and a full hybrid.

STATE BOARD OF TECHNICAL EDUCATION &TRAINING, TELANGANA

EE-505B, ELECTRIC VEHICLES

MID SEM -II MODEL PAPER

TIME: 60 min **TOTAL MARKS: 20**

Important Note: Wherever any question has a choice, marks will be allotted only to the first attempted question. No marks will be allotted for extra questions answered.

PART – A **Marks: 4Q X 1= 04**

Instructions: (1) Answer all questions

(2) Each question carries One mark.

1. State the purpose of Traction Battery Pack
2. State about Depth of Discharge.
3. Define the purpose of the Charging Station.
4. Define the term EV acceptance rate.

PART – B **Marks: 2Q X 3= 06**

Instructions:(1) Answer all questions

(2) Each question carries **Three** marks.

5(a) List the types of Electric motors AC/DC

----OR----

5(b) List the advantages of DC motors over AC.

6(a) Understand AC and DC Charging

.

----OR----

6(b) List the five basic types of EV connectors

PART – C **Marks: 2Q X 5= 10**

Instructions: (1) Answer all questions

(2) Each question carries **Five** marks.

7(a) Explain the construction and working of a Permanent magnet motor

----OR----

7(b) Differentiate between Cell monitoring Controller and battery monitoring Controller,

8(a) Explain the purpose of power factor correction in an On-Board Charger (OBC

----OR----

8(b) Explain the purpose of Open Charge Point Protocol (OCPP)

.

STATE BOARD OF TECHNICAL EDUCATION &TRAINING, TELANGANA

EE-505B, ELECTRIC VEHICLES

SEE MODEL PAPER

TIME: 60 min **TOTAL MARKS: 40**

Important Note: Wherever any question has a choice, marks will be allotted only to the first attempted question. No marks will be allotted for extra questions answered

PART – A **Marks: 8Q X 1= 08**

Instructions: (1) Answer all questions

(2) Each question carries One mark.

1. State the need for a gearbox

2. List any two main types of batteries used in EVs

3. State any two maintenance schedules of EVs.

4. State about Charge Cycle.

5 List any Two components of EV.

6. List the Types of Electric motors used in EV

7. Define the Smart Grid

8. State the term EV Co-ordination

PART – B **Marks: 4Q X 3= 12**

Instructions:(1) Answer Any **Four** questions

(2) Each question carries **Three** marks.

9(a) Enumerate the differences between series hybrid and parallel HEV

----OR----

9(b) Advantages of DC motors over AC motors

.

10(a) Name five protective measures for EV batteries

----OR----

10(b) State the need for EV integration with renewable energy

11(a) State the role of the Electric motor as Propulsion unit

----OR----

11(b) Explain about two components used in EV

12(a) Describe the challenges associated with integrating Electric vehicles with renewable energy sources

----OR----

12(b) How an overcharging and overheating impact the performance and safety of EV

PART – B **Marks: 4Q X 5= 20**

Instructions: (1) Answer Any **Four** questions
(2) Each question carries **Five** marks.

13(a) Explain the construction and working of single plate clutch

----OR----

13(b) Explain the role of MOSFET – IGBT in the drive control of Electric vehicles

.

14(a) List any five differences between a charging station (EVCS) and a charging point (EVSE).

----OR----

14(b) Explain EV integration with Wind energy

15(a) Explain the construction and working of BLDC Motors

----OR----

15(b) Explain the construction and working of a Permanent magnet Synchronous motor,

16(a) Summarise the service and maintenance schedules of EV

----OR----

16(b) Explain the procedure to dispose of a dead battery disposal.

ME-506A INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Course Title	**Introduction to Artificial Intelligence**	Course Code	**ME-506A**
Semester	**V Semester**	Course Group	**Elective**
Teaching Scheme in Hrs(L:T:P)	**4:1:0**	Credits	**2.5**
Methodology	**Lecture + Tutorial**	Total Contact Periods	**75**
CIE	**60 Marks**	SEE	**40 Marks**

Pre requisites

Knowledge of Mathematical and Logical skills.

Course Outcomes

Upon completion of the course the student shall be able to

Course Outcome	
CO1	Understand the basic concepts of Artificial Intelligence
CO2	Apply the Probability functions for solving AI Problems.
CO3	Illustrate the concept of Problem state space representation and Searching
CO4	Apply various Knowledge representation and Inference Techniques
CO5	Apply various AI techniques to Game playing
CO6	Apply Reasoning under uncertainty methods for AI problems

Course Content

1. Introduction to Artificial Intelligence

Duration: 15 Periods (Theory: 13, Tutorial: 2)

Artificial Intelligence - definition, features & limitations, types of AI, applications, challenges, Building blocks of AI, - Domains of Learning. Areas of AI - Expert Systems, Deep Learning, Computer Vision, Natural Language processing, Robotics, AI Ethics and Safety.

2. Mathematics Foundation to Artificial Intelligence

Duration: 12 Periods (Theory: 10, Tutorial: 2)

Introduction to Probability - State the Importance of Probability to AI - Conditional Probability - Multiplication rule of Probability - Probability Distribution - Random Variables - Bernoulli Trails and Binomial Distribution

3. Problems and State Space Search Methods in AI

Duration: 17 Periods (Theory: 15, Tutorial: 2)

Percept and Rationality - Agents and type of Agents - Environment and types of Environment. Problem as a State Space Search – Problem Characteristics – production system – Searching problems, solutions – Un-informed Searching strategy - Breadth First Search, Depth First Search, InformedSearching strategy - Hill climbing.

4. Knowledge Representation, Logic and Inference

Duration: 10 Periods (Theory: 8, Tutorial: 2)

Knowledge representation - types of Knowledge - Knowledge representation issues - **Propositional logic, Rules of Inference,** First Order Logic, Inference in First Order Logic,Unification in First Order Logic, Horn Clause, Definite Clause, Backward and Forwardchaining.

5. Games and AI

Duration: 10 Periods (Theory: 8, Tutorial: 2)

Importance of AI for Games - Game theory - Types of Games - Game Tree, Min max algorithm – Alpha_Beta Pruning Algorithm - Evaluation function - Algorithm for a Tic Tac Toe game.

6. Reasoning under Uncertainty and AI Applications

Duration: 15 Periods (Theory: 13, Tutorial: 2)

Resoning under Uncertainty – Methods for handling uncertainty, Probabilistic Reasoing, Bayes Belief Network.

Solve basic AI problems: Water jug problem, 8-Queen problem.

Applications of AI: Robotics, Automotives, E-commerce, Education, Agriculture, Healthcare, Astronomy, Gaming, Finance, Social Media.

Recommended Books

1. Artificial Intelligence, 3rd Edn, E. Rich and K.Knight (TMH)
2. Artificial Intelligence, A Modern Approach, 3rd Edition, S. Russell, Peter Norvig, PHI.
3. Artificial Intelligence, 3rd Edn., Patrick Henny Winston, Pearson Education
4. Artificial Intelligence, Shivani Goel, Pearson Education.
5. Artificial Intelligence and Expert systems – Patterson, Pearson Education

Recommended Web Resources:

1. https://www.javatpoint.com/artificial-intelligence-tutorial
2. www.w3schools.com
3. http://github.com

Specific Learning Outcomes:

Upon completion of the course the student shall be able to

CO1: Understand the basic concepts of Artificial Intelligence

1.1 Define Artificial Intelligence
1.2 List the features of Artificial Intelligence
1.3 Identify the limitations of Artificial Intelligence
1.4 List the Types of AI
1.5 Define Artificial Narrow Intelligence
1.6 Define Artificial General Intelligence
1.7 Define Artificial Super Intelligence
1.8 List Applications of AI
1.9 Identify the Challenges of AI
1.10 Demonstrate building blocks of AI
1.11 Explain the Domains of Learning
1.12 Define Turing Test
1.13 Illustrate Intelligent behavior of a machine using Turing Test
1.14 List different areas / domains of AI
1.15 Define Expert System
1.16 List different Expert Systems
1.17 Define Computer Vision
1.18 List main features of Computer Vision
1.19 Define Deep Learning
1.20 Define Natural Language Processing
1.21 Demonstrate how NLP works

CO2: Apply the Probability functions for solving AI Problems

2.1 List the Importance of Probability
2.2 Define Sample Space
2.3 Define Event
2.4 Show the Importance of Probability to AI
2.5 Illustrate Conditional Probability with Simple Problems
2.6 Illustrate Multiplication theorem on probability with Simple Problems
2.7 Illustrate Independent Events, Total Probability with Simple Problems
2.8 Illustrate Bayes' Theorem with Simple Problems
2.9 Define Probability Distribution
2.10 Demonstrate Random Variables and its Probability Distribution
2.11 Explain Bernouli Trails and Binomial Distribution with examples
2.12 Define Discrete Probability Distribution
2.13 Define Continuous Distribution
2.14 Define Joint Distribution
2.15 Define Multivariate Distribution

CO3: Illustrate the concept of Problem state space representation and Searching

3.1 Define Percept and Rationality
3.2 Demonstrate Agents and type of Agents
3.3 Define Environment
3.4 List the types of Environment

3.5 Define the problems as a state space search.
3.6 List the Problem Characteristics.
3.7 Define the production system.
3.8 Demonstrate the Production systems.
3.9 List the Features of Production system.
3.10 Explain about Searching problems, solutions
3.11 Define Un-informed Searching strategy.
3.12 Define Informed Searching strategy
3.13 Define Breadth First Search
3.14 Illustrate the Breadth First Search with an example
3.15 Define Depth First Search
3.16 Define Hill climbing
3.17 Illustrate the Hill Climbing with an example
3.18 Compare Breadth First Search and Depth First Search
3.19 List the problems suitable for BFS, DFS and Hill Climbing

CO4: Apply various Knowledge representation and Inference Techniques

4.1 Define Knowledge Representation
4.2 List the types of Knowledge Representation
4.3 Summarize different types of Knowledge representations
4.4 Define Declarative Knowledge, Procedural Knowledge, Meta Knowledge, Heuristic Knowledge,Structural Knowledge
4.5 What is the difference between Knowledge and Intelligence
4.6 Identify the requirements for Knowledge representation system.
4.7 Identify the issues in Knowledge Representation
4.8 Demonstrate the AI Knowledge Cycle
4.9 List different approaches to Knowledge representation
4.10 Define a Proposition
4.11 List the different Logical Connective in Proposition logic
4.12 Illustrate converting simple facts into proposition logic
4.13 List and explain propositional equivalences with examples
4.14 Define First Order Logic / Predicate Logic
4.15 List and explain basic Elements of first order logic
4.16 List and explain different Quantifiers in first order logic
4.17 Demonstrate how to convert statements into First Order logic
4.18 Illustrate inference in First order logic
4.19 Define Unification in FOL
4.20 Define Horn Clause
4.21 Define Definite Clause
4.22 Demonstrate Forward Chaining method with an example
4.23 Demonstrate Backward Chaining method with an example
4.24 Compare Forward Chaining with Backward Chaining

CO5: Apply various AI techniques to Game playing

5.1 What is the Importance of AI in Gaming Industry
5.2 List the applications of AI in Gaming Industry
5.3 List out the limitations of AI in Gaming Industry

5.4 List different types of Games according to Game theory
5.5 Define Game Tree.
5.6 Illustrate formalization of Game as State Space representation
5.7 How to represent Tic-Tac-Toe Game as Game Tree.
5.8 Define Min-Max Algorithm.
5.9 Illustrate Min-Max Algorithm and its working with an example.
5.10 Define Alpha_Beta Pruning algorithm.
5.11 Illustrate Alpha_Beta Pruning Algorithm and its working with an example.

CO6: Apply Reasoning under uncertainty methods for AI problems

6.1 Define Reasoning under uncertainty
6.2 List the causes of uncertainty
6.3 List the method for handling uncertainty
6.4 Define Probabilistic Reasoning
6.5 Define conditional and unconditional probabilities
6.6 Define chain rule
6.7 Apply Bayes rule for Inference
6.8 Define Bayes Belief Network
6.9 Illustrate Bayes Belief Network with an example
6.10 Demonstrate solution of Water Jug Problem
6.11 Demonstrate solution of 8-Queen problem
6.12 Demonstrate the application of AI in the areas such as

a. Robotics
b. Automotives
c. E-Commerce
d. Education
e. Agriculture
f. Healthcare
g. Astronomy
h. Gaming
i. Finance
j. Social Media

Suggested Student Activities

Note: The following activities or similar activities for assessing 2.5 credits (Any one)

Student activity like mini-project, quizzes, etc. should be done in group of 5-10 students.

1. Each group should do any one of the following type of activity or any other similar activity related to the course with prior approval from the course coordinator and program coordinator concerned.
2. Each group should conduct different activity and no repetition should occur.
3. Explore and analyse topics to improve the level of creativity and analytical skill by taking Quiz/ tests/ assignments. Documents have to be maintained as a record.
4. Create a power point presentation on the topic relevant to course or advanced topic as an extension to the course to improve the communication skills. Documents have to be maintained as a record.
5. Visit different sites relevant to topics. Listen to the lectures and submit a handwritten report
6. Coding competitions.

CO-PO Mapping Matrix:

	Basic and Discipline Specific Knowledge	**Problem Analysis**	**Design/Development of Solutions**	**Engineering Tools, Experimentation and Testing**	**Engineering Practices for Society, Sustainability and Environment**	**Project Management**	**Lifelong Learning**	**Linked PO**
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**	
CO1	2						1	1,7
CO2	2	1	1				1	1,2,3,7
CO3	2	2	1				1	1,2,3,7
CO4	2	2	1				2	1,2,3,7
CO5	2	2	1				2	1,2,3,7
CO6	2	2	1				2	1,2,3,7

MODEL QUESTION PAPER

DIPLOMA BOARD MID SEM-I SEMESTER EXAMINATIONS (C-24)

ME-506A Introduction to Artificial Intelligence

Duration : 1 Hour | Maximum Marks: 20

PART-A

Instructions: **(1) Answer all questions.** **4x1 = 4 Marks**

(2) Each question carries ***one*** mark.

1. Define Artificial Intelligence
2. List any two applications of AI
3. Define Probability
4. Define Sample Space

PART-B 2×3=6 Marks

Instructions: **(1) Answer *one* question each from 5 and 6**

(2) Each Question is of internal choice type

(3)Each question carries ***three*** marks

5 (a). Explain evolution of Artificial Intelligence

OR

5 (b). Explain Different Stages of AI

6(a). Explain Conditional Probability with an Example.

OR

6(b). Explain Independent Events with an Example

PART-C 2×5=10 Marks

Instructions: **(1) Answer one question each from 7 and 8.**

(2)Each Question is of internal choice type

(3)Each question carries *five* marks.

7(a). Explain any five challenges due to use of Artificial Intelligence

OR

7(b). Illustrate Intelligent behavior of a machine using Turing test.

8 (a). In a school, there are 1000 students, out of which 430 are girls. It is known that outof 430, 10% of the girls study in class XII. What is the probability that a student chosen randomly studies in Class XII given that the chosen student is a girl?

OR

8 (b). An urn contains 10 black and 5 white balls. Two balls are drawn from the urn oneafter the other without replacement. What is the probability that both drawn balls are black?

MODEL QUESTION PAPER

DIPLOMA BOARD MID SEM-II SEMESTER EXAMINATIONS

ME-506A Introduction to Artificial Intelligence

Duration : 1 Hour Maximum Marks: 20

PART-A

Instructions: **(1) Answer all questions.** **4x1 = 4 Marks**

(2) Each question carries ***one*** mark.

1. Define Agent
2. List any two types of Environments.
3. Define Horn Clause
4. Define Proposition

PART-B 2×3=6 Marks

Instructions: **(1) Answer *one* question each from 5 and 6**

(2) Each Question is of internal choice type

(3) Each question carries *three* marks

5a. Explain any two types of Environments

OR

5b. Explain BFS algorithm

6a. Demonstrate Forward Chaining method

OR

6b. How AI is utilized in Natural Language Processing.

PART-C 2×5=10 Marks

Instructions: **(1) Answer one question each from 7 and 8.**

(2)Each Question is of internal choice type

(3)Each question carries *five* marks.

7a. Explain types of Agents

OR

7b. Explain Hill Climbing Algorithm

8a. Illustrate Backward chaining with an example

OR

8b. Demonstrate how convert simple facts into propositional logic.

BOARD DIPLOMA SEMESTER END EXAMINATION

ME-506A Introduction to Artificial Intelligence

Duration : 2 Hours Marks: 40

PART-A

Instructions: **(1) Answer all questions.** **8x1 = 8 Marks**

(2) Each question carries ***one*** mark.

1. What is Turing Test?
2. Define discrete probability distribution.
3. Define Deep Learning
4. Define uninformed search strategy
5. Define Predicate Logic
6. Define knowledge representation.
7. List any two forms of Learning
8. Define Horn Clause

PART-B

Instructions: **(1) Answer *one* question each from 9,10,11 and 12.** **4 x 3 =12 Marks**

(2) Each Question is of internal choice type

(3) Each question carries *three* marks.

9(a). How AI is utilized in Natural Language Processing.

OR

9(b). How to structure facts and representations?

10(a). List the conditions to be satisfied by Bernoulli trials.

OR

10(b). Define Clustering. Give Example for Clustering

11(a). Write about instance and ISA relationship.

OR

11(b). How to represent simple fact in logic? 12(a).

Define Classification and give examples.

OR

12(b). Define Activation function. List various activation functions.

PART-C

Instructions: **(1) Answer one question each from 13,14, 15 and 16. 4×5=20 Marks**

(2) Each Question is of internal choice type

(3) Each question carries *five* marks

13(a).Explain how to use Google teachable machine

OR

13(b).Explain Issues in Knowledge Representation.

14a. Ten eggs are drawn successively with replacement from a lot containing 10%defective eggs. Find the probability that there is at least one defective egg.

OR

14b. Demonstrate Min-Max Algorithm.

15a. Explain various approaches for knowledge representation.

OR

15b. Explain types of Knowledge.

16a. Demonstrate solution of Water jug problem.

OR

16b. Explain any Five applications of AI.

ME-506B-MECHATRONICS

Course Title:	**Mechatronics**	**Course Code:**	**ME-506B**
Semester:	**V**	**Course group :**	**Elective**
Teaching Scheme(L:T:P):	**4:1:0**	**Credits:**	**2.5**
Methodology :	**Lecture + Assignment**	**Total contact periods:**	**75**
CIE:	**60 Marks**	**SEE:**	**40 Marks**

Prerequisites: Knowledge of Basic Science and Engineering

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1	Illustrate the importance of Mechatronics with control systems, mathematical models and engineering systems.
CO2	Describe the different sensors with applications
CO3	Describe different various Drives, Actuators and Controllers
CO4	Illustrate Programmable Logic Controller (PLC) Controllers with different Programming Languages
CO5	Design a Mechatronic system for a given application using sensors, actuators, drives and Controllers
CO6	Describe the Kinematics of Robot with Trajectory planning

Blue Print of Marks for SEE:

<table>
<tr><th colspan="2" rowspan="2">Units</th><th rowspan="2">No of periods</th><th colspan="4">Questions to be set for SEE</th><th rowspan="2">Remarks</th></tr>
<tr><th colspan="2">R</th><th>U</th><th>A</th></tr>
<tr><td rowspan="2">Part-A</td><td>1. Introduction to Mechatronics</td><td>12</td><td rowspan="6">Q4</td><td colspan="2" rowspan="2">Q1</td><td rowspan="2">Q9(a)</td><td rowspan="2">Q13(a)</td><td rowspan="2"></td></tr>
<tr><td>2. Sensors and applications</td><td>13</td></tr>
<tr><td rowspan="2">Part-B</td><td>3. Drives, Actuators and Controllers</td><td>12</td><td colspan="2" rowspan="2">Q2</td><td rowspan="2">Q10(a)</td><td rowspan="2">Q14(a)</td><td rowspan="2"></td></tr>
<tr><td>4. Programmable Logic Controller (PLC)</td><td>13</td></tr>
<tr><td rowspan="2">Part-C</td><td>5. Design of Mechatronic systems</td><td>13</td><td rowspan="2">Q3</td><td>Q5
Q6</td><td>Q9(b)
Q11(a)
Q11(b)</td><td>Q13(b)
Q15(a)
Q15(b)</td><td rowspan="2"></td></tr>
<tr><td>6. Robot kinematics</td><td>12</td><td>Q7
Q8</td><td>Q10(b)
Q12(a)
Q12(b)</td><td>Q14(b)
Q16(a)
Q16(b)</td></tr>
<tr><td colspan="2">TOTAL</td><td>75</td><td colspan="2">08</td><td>08</td><td>08</td><td></td></tr>
</table>

COURSE CONTENT

7. Introduction to Mechatronics:

Importance of Mechatronics – Mechatronic System - Measurement system - Control system and their types: Open and Closed-loop control.

System Model: Mechanical Systems: Rotational, Translational Systems - Hydraulic and Pneumatic Systems - Fluid Systems - Thermal Systems – Electrical Systems - Electro-Mechanical System - System Modeling methods/techniques/approaches. Introduction to Mathematical model - Mechanical System building blocks - Electrical System building blocks - Fluid System building blocks -Thermal System building blocks.

8. Sensors and Applications:

Sensors characteristics,; Principles and Applications of the following types of sensors: Position sensors (Encoders, Resolvers) - Range sensors (Triangulation Principle, Structured lighting approach) - Velocity sensors - Acceleration sensors- Torque sensors - - Proximity sensing - Lighten infrared sensors -Touch and Tactile sensors - Temperature,

Pressure and Flow transducers - Resistive - Inductive and Capacitive sensors - Industrial Applications.

9. Drives, Actuators and Controllers

Actuators: Hydraulic - Pneumatic and Electrical drives - Linear actuator - Rotary drives: AC servo motor - DC servo motors and Stepper motors - Conversion between linear and rotary motion - switching devices (Relay, Metal Oxide Semiconductor Field Effect Transistor (MOSFET) and Insulated Gate Bipolar Transistor (IGBT)), Solenoids – microcontroller and interfacing.

10. Programmable Logic Controller (PLC)

Definition - Basic block diagram and structure of PLC - Input/output processing - PLC Programming: Ladder diagram - its logic functions - Latching and Sequencing - PLC mnemonics – Timers - Internal relays and Counters - Shift registers - Master and Jump Controls - Data handling - Analog input/output - Selection of PLC - types of PLC- Case studies

11. Design of Mechatronic systems

Design process stages - Traditional Vs Mechatronics designs - possible design solutions - Case studies of Mechatronics systems: pick-and-place pneumatic system - automatic car parking system - Car engine management system - Automatic Washing Machine, CNC based manufacturing systems.

12. Robot kinematics

Kinematic Pair – Classification, Types, Examples, Degrees of freedom, Differences of closed loop and open loop mechanism, Grubler's rule to find the degrees of freedom of kinematic link with examples - Degrees of freedom of robot – Definition of Forward Kinematics and Inverse Kinematics; Mathematical Expressions for Forward Kinematics and Inverse Kinematics of planar manipulator of Two Degrees of Freedom with rotary joints using geometric and algebraic approach - Simple Problems on planar manipulator with two rotary joints. Difference between Trajectory Vs. Path – Cubic polynomial trajectory – Displacement, Velocity and Acceleration of a joint with one degree of freedom.

Text Books:

1. S.K.Saha, "Introduction to Robotics", Second Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2014.
2. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
3. Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.
4. W.Bolton, "Mechatronics" , Pearson education, second edition, fifth Indian Reprint,

2003.
5. Smaili and F. Mrad, "Mechatronics- integrated technologies for intelligent machines", Oxford university press, 2008.

Reference Books:

1. Mechatronics – W. Bolton, Pearson Education India.
2. A Text Book on Mechatronics – R.K.Rajput, S. Chand & Co, New Delhi.
3. Exploring Programmable Logic Controllers with applications Pradeep Kumar Srivatsava, BPB Publications.
4. Michael B. Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 2000. D. A. Bradley, Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall,1993.
5. Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).
6. Lawrence J. Kamm, "Understanding Electro – Mechanical Engineering", An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.
7. Nitaigour Premchand Mahadik, "Mechatronics", Tata McGraw-Hill publishing Company Ltd, 2003.

ELECTRONIC RESOURCES

1. https://nptel.ac.in/courses/
2. https://www.slideshare.net/
3. https://en.wikipedia.org/wiki/
4. http://ndl.ethernet.edu.et/bitstream/

SUGGESTED LEARNING OUTCOMES

1. Introduction to Mechatronics

1.1. Describe the scope and importance of Mechatronics.
1.2. Explore the knowledge on measurement and control systems
1.3. Explore the different types of control systems
1.4. Distinguish between Open and Closed-loop control Systems with examples.
1.5. Illustrate the Mathematical Model of a system.
1.6. Describe the Mechanical and Electrical system building blocks.
1.7. Describe the Fluid System building blocks.
1.8. Describe the Thermal System building blocks
1.9. Illustrate what is system model and List the different Engineering System Models.
1.10. Describe the concept of engineering system model with simple examples
1.11. Explain the System Modeling methods/techniques/approaches.
1.12. Describe the Rotational System models
1.13. Describe the Translational System models

1.14. Illustrate the Hydraulic System Models
1.15. Illustrate the Electrical System Models
1.16. Illustrate the Thermal Engineering System Models
1.17. Illustrate the Electro-Mechanical Engineering System Model

2. Sensors & Applications

2.1. Classify different sensors used in mechatronics
2.2. Describe the principle of different sensors
2.3. Describe the functions of different sensors
2.4. Describe the characteristics of sensor
2.5. Illustrate the principle and applications of position sensors (Encoders, Resolvers, Piezo-Electric)
2.6. Illustrate the principle and applications of range sensors (Triangulation principle, structured lighting approach)
2.7. Illustrate the principle and applications of velocity sensors
2.8. Illustrate the principle and applications of acceleration sensors
2.9. Illustrate the principle and applications of Force sensors
2.10. Illustrate the principle and applications of Torque sensors
2.11. Illustrate the principle and applications of proximity sensors
2.12. Illustrate the principle and applications of Lighten infrared sensors
2.13. Illustrate the principle and applications of Touch sensors
2.14. Illustrate the principle and applications of Tactile sensors
2.15. Illustrate the principle and applications of Temperature sensor
2.16. Illustrate the principle and applications of Pressure sensors
2.17. Illustrate the principle and applications of Flow sensors.
2.18. Illustrate the principles and applications of Resistive sensors
2.19. Illustrate the principle and applications of Inductive sensors
2.20. Illustrate the principle and applications of capacitive sensors.

3. Drives, Actuators and Controllers:

3.1. Explore the different drive systems of engineering systems such as hydraulic, pneumatic and electric
3.2. Explore the different Actuators such as linear and rotary
3.3. Describe the working of AC servo motor
3.4. Describe the working of DC servo motor
3.5. Describe the working of stepper motors
3.6. Illustrate the conversion between linear and rotary motion with examples
3.7. Illustrate the concept of switching devices
3.8. Illustrate the concept of Relay

3.9. Illustrate the principle of MOSFET
3.10. Illustrate the principle of IGBT
3.11. Distinguish between IGBT and MOSFET
3.12. Illustrate the block diagram of IGBT
3.13. Describe the concept of Solenoids with simple examples in different engineering fields
3.14. Explore the concept of microprocessor based control system

4. Programmable Logic Controller (PLC

4.1. Describe the basic definition and concept of PLC
4.2. Illustrate the basic block diagram and structure of PLC
4.3. Describe the concept of Input/output processing
4.4. Illustrate the basic PLC Programming and types
4.5. Describe the Ladder diagram and its logic functions
4.6. Describe the Latching and Sequencing of PLC
4.7. Illustrate the concept of mnemonics, Timers, Internal relays and Counters
4.8. Illustrate the concept of shift registers, Master and Jump Controls, Data handling & Analog input/output in PLC
4.9. Describe the selection of PLC

5. Design of Mechatronic systems

5.1. Explore the design stages in Mechatronics
5.2. Distinguish between Traditional vs. Mechatronics designs
5.3. Describe the case study of Mechatronics system: Pick-and-place pneumatic system in a robot
5.4. Describe the case study of Mechatronics system: Car parking system
5.5. Describe the case study of Mechatronics system: Car engine management system
5.6. Describe the case study of Mechatronics system: Automatic Camera
5.7. Describe the case study of Mechatronics system: Automatic Washing Machine
5.8. Describe the case study of Mechatronics system in CNC Machines to operate tool, table
5.9. Describe the case study of Mechatronics system in CNC Machines for selecting speed, feed and depth of cut.

6. Robot kinematics

6.1. Define kinematic pair
6.2. Classify kinematic pairs with examples

6.3. Differentiate closed loop and open loop mechanism
6.4. Illustrate the Grubler's rule to find the Degrees of freedom of kinematic link
6.5. Define Degrees of freedom of robot
6.6. Define Forward kinematics and Inverse kinematics of robot
6.7. Derive the mathematical expression for *Forward kinematics* of planar manipulator of two degrees of freedom with rotary joints using *geometric approach.*
6.8. Derive the mathematical expression for *Forward kinematics* of planar manipulator of two degrees of freedom with rotary joints using *algebraic approach*
6.9. Derive the mathematical expression for *Inverse kinematics* of planar manipulator of two degrees of freedom with rotary joints using *geometric approach*.
6.10. Derive the mathematical expression for *Inverse kinematics* of planar manipulator of two degrees of freedom with rotary joints using *algebraic approach*.
6.11. Solve the Simple Problems on planar manipulator with two rotary joints using geometric and algebraic approach.
6.12. Define Trajectory and Path of Robot
6.13. Differentiate Trajectory and Path of the Robot
6.14. Expressions for Displacement, Velocity and Acceleration in cubic polynomial trajectory of a joint with one degree of freedom
6.15. Example for cubic polynomial trajectory for Displacement, Velocity and Acceleration of a joint with one degree of freedom

COURSE OUTCOMES		**CL**	**Linked POs**	**Teaching Periods**
CO1	Illustrate the importance of Mechatronics with control systems, mathematical models and engineering systems.	R, U, A	1,2,4,7	10
CO2	Describe the different sensors with applications	R, U, A	1,3,4,6,7	10
CO3	Describe different various Drives, Actuators and Controllers	R, U, A	1,2,3,4,7	13
CO4	Illustrate Programmable Logic Controller (PLC) Controllers with different Programming Languages	R, U, A	1,4,7	14
CO5	Design a Mechatronic system for a given application using sensors, actuators, drives and Controllers	R, U, A	1,2,3,4,6,7	14
CO6	Describe the Kinematics of Robot with Trajectory planning	R, U, A	1,2,3,4,7	14
Total Periods				**75**

Legends: R = Remember; U= Understand; A= Apply and above levels (Bloom's revised taxonomy)

CO-PO Attainment Matrix:

CO'S	PROGRAM OUTCOMES						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	-	2			2
CO2	3	-	1	2		1	2
CO3	3	2	1	1			2
CO4	3	-	-	2			3
CO5	3	-	1	2		1	2
CO6	3	2	1	2			2

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Lowly Addressed**.**

MID SEM-I EXAM

Unit No	Unit Name	R	U	A	Remarks
1	**Introduction to Mechatronics**	1, 2	5(a) 5(b)	7(a) 7(b)	
2	**Sensors and applications**	3, 4	6(a) 6(b)	8(a) 8(b)	
Total Questions		4	4	4	

MID SEM-II EXAM

Unit No	Unit Name	R	U	A	Remarks
3	**Drives, Actuators and Controllers**	1, 2	5(a) 5(b)	7(a) 7(b)	
4	**Programmable Logic Controller (PLC)**	3, 4	6(a) 6(b)	8(a) 8(b)	
Total Questions		4	4	4	

MID SEM-I EXAM

Model Paper

ME-506E(B) - Mechatronics

Time: 1 hr | Max. Marks: 20

PART-A | 4x1=4 Marks

NOTE: 1) Answer all questions and each one carries one mark.

1. What is Mechatronics?
2. List the control systems in Mechatronics.
3. List any two sensors used in an engineering system
4. Write the principle of proximity sensor.

PART-B | 2x3 M= 6 Marks

NOTE: Answer all questions and each one carries three marks.

5(a). Distinguish between Traditional design and Mechatronics design

Or

5(b). Illustrate the Mathematical Model of a system.

6(a). List any three functions of sensors.

Or

6(b). Illustrate the principle of Torque sensors

PART-C | 2x5 M= 10 Marks

NOTE: 1) Answer all questions and each one carries Five marks.

7(a). Illustrate the Electrical System Models

Or

7(b). Illustrate the Thermal Engineering System Models

8(a). Illustrate the principle and applications of tactile sensors

Or

8(b). Illustrate the principle and applications of pressure sensors

MID SEM-II EXAM

Model Paper

ME-506E (B) - Mechatronics

Time: 1 hr | Max. Marks: 20

PART-A | 4x1=4 Marks

NOTE: 1) Answer all questions and each one carries one mark.

1. List any two types of drive systems in mechatronics
2. What is the purpose of Relay?
3. What is sequencing?
4. Define latching.

PART-B | 2x3 M= 6 Marks

NOTE: Answer all questions and each one carries three marks.

5(a). Describe the working of DC servo motor.

Or

5(b). Illustrate the principle of IGBT.

6(a). Briefly describe the ladder diagram.

Or

6(b). Describe the concept of sequencing in PLC.

PART-C | 2x5 M= 10 Marks

NOTE: 1) Answer all questions and each one carries Five marks.

7(a). Illustrate the principle of MOSFET

Or

7(b). Illustrate the principle of IGBT

8(a). List any points to be considered while selecting PLC

Or

8(b). Write a brief note on the concept of mnemonics

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SEMESTER END EXAMINATIION

MODEL PAPER

ME-506E (B) - MECHATRONICS

Time: 2 hrS Max. Marks: 40

PART-A 8x1=8 Marks

NOTE: 1) Answer all questions and each one carries one mark.

1. What is Mechatronics?
2. What is the purpose of Relay?
3. Define degrees of freedom of robot.
4. What is the principle of proximity sensor?
5. What do you understand by "synthesis" in design process?
6. What is Mechatronics approach in design?
7. Define kinematic pair.
8. Write the equation of Grublers rule for DoF of a kinematic chain.

PART-B 4x3 M= 12Marks

NOTE: Answer all questions and each one carries three marks.

9(a). Define sensor and name any two major functions of sensors in robots

Or

9(b). Write short notes on mechatronics approach in design.

10(a). Write a short note on IGBT.

. Or

10(b). Write a short note on forward kinematics of a robot

11(a). What is the traditional approach for wind-screen wiper motion?

Or

11 (b). Write the working principle of bathroom scale using traditional mechanical system.

12 (a). Illustrate the Grubler’s rule to find the Degrees of freedom of kinematic link

Or

12 (b). Differentiate Trajectory and Path of the Robot

PART-C 4x5 M= 20 Marks

NOTE: 1) Answer all questions and each one carries Five marks.

13(a). Explain the basic functions of a sensor.

Or

13(b). Explain the automatic car parking system using PLCs with a block diagram.

14 (a). Explain the working principle of DC servo motor.

Or

14(b). Derive the mathematical expression for *Forward kinematics* of planar manipulator of two degrees of freedom with rotary joints using *algebraic approach.*

15(a). Explain pick and place robot with possible design solution.

Or

15(b). Draw the block diagram of car engine management system**.**

16(a). Derive the mathematical expression for *Inverse kinematics* of planar manipulator of two degrees of freedom with rotary joints using *algebraic approach*.

Or

16(b). Expressions for Displacement, Velocity and Acceleration in cubic polynomial trajectory of a joint with one degree of freedom

ME-507 Manufacturing &Automation Lab

CourseTitle :	Manufacturing & Automation Lab	Course Code	ME-507
Semester	V	Course Group	Practical
TeachingScheme inperiods(L:T:P)	1:0:2	Credits	1.25
Methodology	Lecture+Practice	TotalContact periods	45Periods
CIE	60 Marks	SEE	40Marks

Course Outcomes:

CO1	Demonstrate a foundational understanding of robot anatomy, including manipulators, end-of-arm tooling (EOAT), sensors, and actuators. Additionally, program basic movements and tasks using robot simulation software.
CO2	Explain the functionalities of CNC lathes. Write basic CNC programs for turning operations and perform simple turning exercises under instructor supervision.
CO3	Explain the functionalities of CNC mills. Develop practical skills through programming and milling exercises under instructor guidance, enabling them to write basic CNC programs for milling operations.
CO4	Describe 3D printing technology, specifically FDM (Fused Deposition Modeling). Utilize slicing software to prepare 3D models for printing. Operate a 3D printer and print simple objects with instructor support.
CO5	Apply their understanding of the working principles of various sensors through hands-on exercises, including limit switches (mechanical and magnetic), encoders (rotary and linear), and photoelectric sensors (reflective and thru-beam).
CO6	Analyze the applications of force sensors in different scenarios through demonstrations and practical exercises. Gain a deeper understanding of sensor technology and its role in various industrial processes.

Prerequisites:

This course requires the Basic Computer Skills, basic mathand understanding of basic electronics/mechanics concepts

Course Content

1. **Industrial Robots** **Duration: 6 periods (T:1 + P:5)**

- **Theory:** Brief introduction to robot anatomy (manipulator, end-of-arm tooling (EOAT), sensors & actuators) (1 hours).
- **Practical:** Robot simulation software for basic movements and programming tasks (5 hours) (Focus on practical exploration and experimentation).

2. CNC Lathe **Duration: 9 periods (T:1 + P:8)**

- **Theory:** Brief demonstration of a CNC lathe and its key functionalities (1 hours).
- **Practical:**G-Code Commands, M-Code Commands, Writing basic CNC programs for Face Turning, Straight Turning ,Tapered Turning, Thread Cutting, Canned Cyclesunder instructor supervision (8 hours)(Focus on practical programming and turning exercises).

3. CNC Mill **Duration: 9 periods (T:1 + P:8)**

- **Theory:** Brief demonstration of a CNC mill and its key functionalities (1 hours).
- **Practical:**G-Code Commands, M-Code Commands, Writing basic CNC programs for Face Milling, Drilling Single Hole, Drilling Cycle for Multiple Holes, Slot Milling, Square Pocket Milling, Circular Pocket Milling, Pocket Milling with Islandunder instructor supervision (8 hours)(Focus on practical programming and milling exercises).

4. 3D Printing **Duration: 9 periods (T:1 + P:8)**

- **Theory:** Brief introduction to 3D printing technologies (FDM) and printer components (1 hour).
- **Practical:** Slicing software for Preparing 3D Models for Printing - 3D printer operation and printing a variety of simple objects with instructor guidance (8 hours).

5. Sensors: **Duration: 12 periods (T:0 + P:12)**

5.1. Sensors & Limit Switches (3 Hours)

Practical: Working principle of limit switches (mechanical and magnetic) explored through practical exercises (Focus on practical application).

5.2. Encoders (3 Hours)

Practical: Exploring the function of encoders (rotary and linear) through practical exercises (Focus on hands-on understanding).

5.3. Photoelectric Sensors (3 Hours)

Practical: Experimenting with different photoelectric sensors (reflective and thru-beam) for object detection and control tasks (Focus on practical application).

5.4. Force Sensors (3 Hours)

5.5. **Practical:** Exploring the applications of force sensors through demonstrations and hands-on practice exercises.

Learning Outcomes:

1. Industrial Robots:

Knowledge and Understanding:

1.1 Define the basic components of an industrial robot: manipulator, end-of-arm tooling (EOAT), sensors, and actuators.

1.2 Explain the functions of each component in robot operation.

1.3 Differentiate between various types of end-of-arm tooling used for different tasks.

1.4 Identify common sensor types used in industrial robots and their applications (e.g., proximity sensors, vision systems).

1.5 Describe the role of actuators in robot movement and control.

Skills and Abilities:

1.6 Utilize robot simulation software to perform basic robot movements (e.g., pick and place, linear motions).

1.7 Apply basic programming commands to control robot motion within the simulation environment.

1.8 Troubleshoot basic issues encountered during robot simulation exercises.

1.9 Communicate effectively the capabilities and limitations of industrial robots.

2. CNC Lathe:

Knowledge and Understanding:

2.1 Explain the basic functionalities of a CNC lathe.

2.2 Differentiate between various types of CNC lathes.

2.3 Define G-code and M-code commands used in CNC lathe programming.

Skills and Abilities:

2.4 Identify and interpret common G-code and M-code commands.

2.5 Write basic CNC lathe programs for face turning, straight turning, tapered turning, thread cutting, and canned cycles.

2.6 Set up and operate a CNC lathe under instructor supervision.

2.7 Analyze and troubleshoot basic CNC lathe programming errors.

3. CNC Mill:

Knowledge and Understanding:

3.1 Explain the basic functionalities of a CNC mill.

3.2 Differentiate between various types of CNC mills.

3.3 Define G-code and M-code commands used in CNC mill programming.

Skills and Abilities:

3.4 Identify and interpret common G-code and M-code commands.

3.5 Write basic CNC mill programs for face milling, drilling single and multiple holes, slot milling, square and circular pocket milling, and pocket milling with islands.

3.6 Set up and operate a CNC mill under instructor supervision.

3.7 Analyze and troubleshoot basic CNC mill programming errors.

4. 3D Printing:

Knowledge and Understanding:

4.1 Explain the basic principles of 3D printing technology (e.g., FDM).

4.2 Identify the key components of a 3D printer.

Skills and Abilities:

4.3 Utilize slicing software to prepare 3D models for printing.

4.4 Operate a 3D printer and print a variety of simple objects under instructor guidance.

4.5 Troubleshoot basic 3D printing problems (e.g., filament jams, poor print quality).

5. Sensors:

Knowledge and Understanding:

5.1 Define sensors and their role in automation and data acquisition.

5.2 Classify different types of sensors based on their operating principle (e.g., mechanical, electrical, optical).

5.3 Describe the working principles of limit switches (mechanical and magnetic) and their applications in industrial settings.

5.4 Explain the function of encoders (rotary and linear) and their use for measuring position and speed.

5.5 Discuss the operation of photoelectric sensors (reflective and thru-beam) for object detection and control tasks.

5.6 Explain the applications of force sensors in measuring pressure, weight, and strain.

Skills and Abilities:

5.7 Select appropriate sensors for specific industrial applications based on their characteristics and functionalities.

5.8 Interpret sensor data and troubleshoot basic sensor malfunctions.

5.9 Wire and connect sensors to control systems following safety protocols.

Recommended Books

1. Industrial Robots:

Industrial Robots: Design, Applications And Technology by Dr. Senthilkumar Selvaraj.

2. CNC Lathe and Milling:

CNC Fundamentals and Programming by P. M. Agrawal and Dr. V. J. Patel.

3. 3D Printing:

The 3D Printing Handbook: Technologies, Design and Applications by Ben Redwood, Filemon Schöffer, and Brian Garret.

4. Sensors:

Industrial Instrumentation and Control by S. K. Singh.

Key competence to be achieved by students / Suggested Learning Outcomes:

Unit	Key Competencies	Suggested Learning Outcomes
Industrial Robots	* Understand robot anatomy and function. * Apply basic robot programming skills. * Analyze robot capabilities and limitations.	* Define the basic components of an industrial robot. * Explain the functions of robot manipulators, EOAT, sensors, and actuators. * Utilize robot simulation software for basic movements and programming tasks. * Communicate effectively the capabilities and limitations of industrial robots.
CNC Lathe	* Understand CNC lathe functionalities and programming. * Perform basic CNC lathe operations. * Analyze and troubleshoot CNC lathe programs.	* Explain the basic functionalities of a CNC lathe. * Define G-code and M-code commands used in CNC lathe programming. * Write basic CNC lathe programs for turning operations (facing, turning, tapering, threading). * Set up and operate a CNC lathe under instructor supervision (consider safety protocols in your country). * Analyze and troubleshoot basic CNC lathe programming errors.

CNC Mill	* Understand CNC mill functionalities and programming. * Perform basic CNC mill operations. * Analyze and troubleshoot CNC mill programs.	* Explain the basic functionalities of a CNC mill. * Define G-code and M-code commands used in CNC mill programming. * Write basic CNC mill programs for milling operations (facing, drilling, slotting, pocketing). * Set up and operate a CNC mill under instructor supervision (consider safety protocols in your country). * Analyze and troubleshoot basic CNC mill programming errors.
3D Printing	* Understand 3D printing technology (FDM). * Operate a 3D printer for basic tasks. * Troubleshoot common 3D printing problems.	* Explain the basic principles of FDM 3D printing. * Identify the key components of a 3D printer. * Utilize slicing software to prepare 3D models for printing. * Operate a 3D printer and print a variety of simple objects under instructor guidance. * Troubleshoot basic 3D printing problems (e.g., filament jams, poor print quality).
Sensors	* Understand different sensor types and their applications. * Select appropriate sensors for specific tasks. * Interpret sensor data and troubleshoot basic malfunctions.	* Define sensors and their role in automation and data acquisition. * Classify different types of sensors based on their operating principle (mechanical, electrical, optical). * Describe the working principles of limit switches, encoders, photoelectric sensors, and force sensors. * Explain applications of various sensors in industrial settings. * Select appropriate sensors for specific industrial applications based on their characteristics and functionalities. * Interpret sensor data and troubleshoot basic sensor malfunctions (consider safety protocols in your country when working with electrical components).

CO-PO MATRIX :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1.50	0.00	3.00	3.00	1.50	1.50	3.00
CO2	1.50	3.00	3.00	3.00	1.50	3.00	3.00
CO3	1.50	3.00	3.00	3.00	1.50	3.00	3.00
CO4	2.00	1.50	3.00	3.00	2.00	3.00	1.00
CO5	3.00	0.00	1.50	1.50	3.00	3.00	1.50
CO6	3.00	0.00	1.50	1.50	3.00	3.00	1.50
AVERAGE	2.08	1.25	2.50	2.50	2.08	2.75	2.17

CourseOutcomes		CL	Linked PO	Teaching Hours
CO1	Demonstrate a foundational understanding of robot anatomy, including manipulators, end-of-arm tooling (EOAT), sensors, and actuators. Additionally, program basic movements and tasks using robot simulation software.	U/A	1,3,4,5,6,7	3
CO2	Explain the functionalities of CNC lathes. Write basic CNC programs for turning operations and perform simple turning exercises under instructor supervision.	U/A	1,2,3,4,5,6,7	12
CO3	Explain the functionalities of CNC mills. Develop practical skills through programming and milling exercises under instructor guidance, enabling them to write basic CNC programs for milling operations.	U/A	1,2,3,4,5,6,7	6
CO4	Describe 3D printing technology, specifically FDM (Fused Deposition Modeling). Utilize slicing software to prepare 3D models for printing. Operate a 3D printer and print simple objects with instructor support.	A	1,2,3,4,5,6,7	6
CO5	Apply their understanding of the working principles of various sensors through hands-on exercises, including limit switches (mechanical and magnetic), encoders (rotary and linear), and photoelectric sensors (reflective and thru-beam).	U/A	1,3,4,5,6,7	3
CO6	Analyze the applications of force sensors in different scenarios through demonstrations and practical exercises. Gain a deeper understanding of sensor technology and its role in various industrial processes.	A	1,3,4,5,6,7	15

MID SEM-I EXAM

S.No	Unit Name	R	A	Remarks
1	Unit-I	1, 2	1	
2	Unit-II	3,4	2	
Total Questions		**4**	**2**	

MID SEM –II EXAM

S.No	Unit Name	R	A	Remarks
1	Unit-III	1, 2	5	
2	Unit-IV	3,4	6	
Total Questions		**4**	**2**	

SEMESTER END EXAM

S N	Unit name	Questions to be set for SEE		Remarks
		R, U	A	
1	Unit-1,2	1,2		
2	Unit-3,4	3,4		
3	Unit-5		5, 6	
Total Questions		**4**	**2**	

ME-507, MANUFACTURING &AUTOMATION LAB

MODEL PAPER FOR MID -1 (CIE)

TIME: 1hr **Marks: 20M**

PART-A

NOTE: Answer all questions 4 X 2 =8marks

1. What are the main components of Industrial Robot.
2. Writeany two basic programming commands to control robot motion.
3. Write any two G-Codesused in CNC lathe programming and mention their purpose.
4. Write any two M-Codes used in CNC lathe programming and mention their purpose.

PART-B

NOTE: Answer any one question. 1 X 12 = 12marks

5. Perform basic robot movements, by utilizing robot simulation software.
6. Write a program to machine a 30 mm diameter steel rod to 25 mm diameter for 40 mm length on a CNC lathe.

ME-507, MANUFACTURING &AUTOMATION LAB

MODEL PAPER FOR MID -2 (CIE)

TIME: 1hr Marks: 20M

PART-A

NOTE: Answer all questions 4 X 2 =8marks

1. Write any two G codes used in CNC mill and mention their purpose.
2. Write any two M codes used in CNC mill and mention their purpose.
3. What are the main components of a 3D Printer?
4. What is the purpose of Slicing software used in 3D Printing.

PART-B

NOTE: Answer any one questions. 1 X 2 =12marks

5. Write a program to Drill four 6 mm diameter holes in a square pattern on a 50 mm x 50 mm aluminum block to a depth of 4mm with each hole centered 10 mm from the edge of the block.
6. Print a cylinder of 20mm diameter and 10 mm height on 3d printer and write the procedure.

ME-507, MANUFACTURING&AUTOMATION LAB

MODEL PAPER FOR SEE

TIME: 2hr **Marks: 40M**

PART-A

NOTE: Answer all questions 4 X 4 =16marks

1. Write the functions of each component in robot.
2. Differentiate between various types of CNC lathes.
3. Write the functions of each component in 3D printer.
4. Write any two type of sensors used in industries and their purpose.

PART-B

NOTE: Answer any one questions. 1 X 24 = 24marks

5. Print a cube of 30mm side on 3d printer and write the procedure.
6. Use a linear encoder to measure distance and speed of an object and write the procedure.

ME-508- METROLOGY AND PNEUMATICS LAB

Course Title:	Metrology and Pneumatics Lab	Course Code:	ME-508
Semester:	V	Course group :	Core
Teaching Scheme(L:T:P):	1:0:2	Credits:	1.5
Methodolgy :	Lecture + Assignment	Total contact periods:	45
CIE:	60 Marks	SEE:	40 Marks

Prerequisites: Basic knowledge of Metrology& pneumatics systems

COURSE OUTCOMES

On successful completion of the course, the students will be able to

Course Outcomes	
CO1	Measure the angle of the machined surface using a sine bar with slip gauges
CO2	Measure the geometrical dimensions of a given thread and spur gear and alignment of a given surface
CO3	Measure the surface roughness and linear displacement
CO4	Construct the pneumatic circuit for direct and speed control of Single & double acting cylinder
CO5	Construct the pneumatic circuit for the Control of a double-acting cylinder using OR logic
CO6	Construct the pneumatic circuit for the Control of a Double-acting cylinder using AND LOGIC

LIST OF EXPERIMENTS

S.No.	Description	No of Periods
	A) METROLOGY LAB	
1	Introduction to Metrology	3
2	Measure the angle of the machined surface using a sine bar with slip gauges	3
3	To measure the screw thread parameters of a given specimen and given spur gear teeth using Tool Maker's Microscope and Gear tooth vernier	6
4	Check the alignment using Autocollimator	3
5	Measurement of displacement using LVDT	3
6	Measurement of surface roughness using Talysurf tester	3
	B) PNEUMATICS LAB	
1	Introduction to Pneumatic Components	3
2	Direct control of a single-acting cylinder	3
3	Direct control of a double-acting cylinder	3
4	Speed control of a double-acting cylinder	3
5	Control of a double-acting cylinder with OR logic	6
6	Control of a double-acting cylinder with AND logic	6
	Total	**45**

REFERENCE BOOKS

1. Engineering Metrology – R. K. Jain
2. Engineering precision metrology – R. C. Gupta
3. A Handbook of Industrial Metrology – ASME
4. Measurement System (Application and Design) – Ernest O Doebelin
5. Pneumatics by SRIHARI RAO
6. Pneumatic controls by FESTO

SUGGESTED LEARNING OUTCOMES

Upon completion of the course, the student shall be able to

1. Introduction to Metrology

1.1. State the need and importance of Metrology

1.2. Define metrology

1.3. Identify various measuring Instruments and their purpose.

2. Measure the angle of the various machined surfaces using a sine bar with slip gauges:

2.1. Identify various parts of the sine bar.

2.2. Demonstrate the usages of slip gauges

2.3. Experiment with the method of finding out angel using a sine bar

2.4. Calculate the angle of the machined surface

3. **To measure the screw thread parameters of a given specimen using Tool Maker's Microscope/Gear tooth vernier:**
   3.1. Define various screw thread parameters
   3.2. Identify various parts of the apparatus
   3.3. Analyse the experimental setup
   3.4. Experiment with the method of finding out various screw thread parameters
4. **Check the alignment using Autocollimator:**
   4.1. Illustrate the concepts and necessity of alignment of parts/surfaces
   4.2. Identify various parts of the apparatus
   4.3. Demonstrate the experimental setup
   4.4. Measure the required parameters with Autocollimator
5. **Measurement of displacement using LVDT:**
   5.1. State the necessity of precision measurement of displacement
   5.2. Identify various parts of the apparatus
   5.3. Demonstrate the experimental setup
   5.4. Measure displacement using LVDT
6. **Measurement of surface roughness using Talysurf tester:**
   6.1. Understanding the concepts of surface roughness and the necessity of measuring surface roughness
   6.2. Identify various parts of the apparatus
   6.3. Demonstrate the experimental setup
   6.4. Measure surface roughness using a Talysurf tester
7. **Introduction to Pneumatic Components**
   7.1. Demonstrate the working of Pneumatic components.
   7.2. Explain Pneumatics
   7.3. Identify & List Symbols used in Pneumatic circuits.
   7.4. Explain the phenomena of compressed air for transmitting power.
   7.5. State Pascal's law.
   7.6. List all the pneumatic applications.
   7.7. Define Pneumatic actuator.
   7.8. Classify the actuators.
   7.9. Explain Linear actuators and Rotary actuators.
   7.10. Define valve.
   7.11. List different types of valves.
   7.12. Explain the function of a valve.
   7.13. Identify the components of a valve.
   7.14. Identify ports and positions.
   7.15. List the Applications of valves.

8. **Direct control of a single-acting cylinder**
   8.1.Draw the circuit diagram for actuating a single-acting cylinder.
   8.2.Select the suitable valve.eg:3/2 valve.
   8.3.Connect the 3/2 valve to the actuator.
   8.4.Actuate the single-acting cylinder by operating a 3/2 valve.
9. **Direct control of a double-acting cylinder**
   9.1. Draw the circuit diagram for actuating a Double-acting cylinder.

9.2. Select the suitable valve.eg:4/2 valve.
9.3. Connect the 4/2 valve to the actuator.
9.4. Actuate the double-acting cylinder by operating a 4/2 valve.

10. Speed control of a double-acting cylinder

10.1. Draw the pneumatic circuit for controlling the speed of a double-acting cylinder
10.2. Select a 4/2 or 5/2 valve and a throttle valve.
10.3. Connect the 4/2 valve and throttle valve as per the circuit.
10.4. Operate the 4/2 valve and adjust the throttle valve to control the speed of the double-acting cylinder

11. Control of a double-acting cylinder with OR logic

11.1. Draw the pneumatic circuit for controlling the speed of the double-acting cylinder using OR logic.
11.2. Select two 3/2 valves and a shuttle valve(OR Valve).
11.3. Connect 3/2 valves and OR valves to the double-acting cylinder as per the circuit.
11.4 Operate either one of the 3/2 valves to control the speed of the double-acting cylinder.

12. Control of a Double-acting cylinder with AND LOGIC

12.1. Draw the pneumatic circuit for controlling the speed of the double-acting cylinder using AND logic.
12.2. Select two 3/2 valves and an AND valve.
12.3. Connect 3/2 valves and AND valves to the double-acting cylinder as per the circuit.
12.4. Operate two valves simultaneously to control the speed of the double-acting cylinder.

COURSE OUTCOMES		**CL**	**Linked POs**
CO 1	Measure the angle of a machined surface using a sine bar with slip gauges	R, U, A	1,2,4,5,6,7
CO 2	Measure the geometrical dimensions of the given thread and spur gear alignment of a given surface	R, U, A	1,2,4,5,6,7
CO 3	Measure the surface roughness and linear displacement	R, U, A	1,2,4,5,6,7
CO 4	Construct the pneumatic circuit for direct and speed control of Single & double acting cylinder	U, A	1,2,3,4,5,6,7
CO 5	Construct the pneumatic circuit for the Control of a double-acting cylinder using OR logic	U, A	1,2,3,4,5,6,7
CO 6	Construct the pneumatic circuit for the Control of a Double-acting cylinder using AND LOGIC	R, U, A	1,2,3,4,5,6,7

Legends: R = Remember; U= Understand; A= Apply and above levels (Bloom's revised taxonomy)

CO-PO Attainment Matrix:

COURSE OUTCOMES	PROGRAM OUTCOMES						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	1	3	-	2	1	3	3
CO2	2	3	-	2	1	3	2
CO3	2	3	-	2	1	3	2
CO4	2	3	1	2	1	3	1
CO5	2	3	1	1	1	3	3
CO6	1	1	2	2	1	3	1

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Lowly Addressed**.**

State Board of Technical Education, Telangana State
Model Paper
ME-508 – METROLOGY LAB PNEUMATICS LAB
Mid Sem-I (CIE)

Time: 1 Hour **Total Marks: 20 M**

Note: Answer any one question.

1. Measure the angle of the machined surface using a sine bar with slip gauges.
2. Measure the screw thread parameters such as pitch, thread angle, and depth of screw of a given specimen using Tool Maker's Microscope/Gear tooth vernier
3. Check the alignment of a given specimen using an Autocollimator.
4. Measure the displacement using LVDT.
5. Measure the surface roughness of a given surface using a Talysurf tester.
6. Connect pneumatic devices and control the direction of a Single Acting Cylinder
7. Connect pneumatic devices and control the direction of a Double Acting Cylinder
8. Connect the Pneumatic controls for Control of a double-acting cylinder with OR logic
9. Connect the Pneumatic controls for Control of a double-acting cylinder with AND logic
10. Connect pneumatic devices and control the speed of a Double Acting Cylinder

Note: Exam should be conducted from the experiments in which students undergo training only as classes are conducted on a rotation basis.

State Board of Technical Education, Telangana State
Model Paper
ME-508 – METROLOGY LAB PNEUMATICS LAB
Mid Sem-II (CIE)

Time: 1 Hour **Total Marks : 20 M**

Note: Answer any one question.

1. Measure the angle of the machined surface using a sine bar with slip gauges.
2. Measure the screw thread parameters such as pitch, thread angle, and depth of screw of a given specimen using Tool Maker's Microscope/Gear tooth vernier
3. Check the alignment of a given specimen using an Autocollimator.
4. Measure the displacement using LVDT.
5. Measure the surface roughness of a given surface using a Talysurf tester.
6. Connect pneumatic devices and control the direction of a single-acting cylinder
7. Connect pneumatic devices and control the direction of a double-acting cylinder
8. Connect the Pneumatic controls for Control of a double-acting cylinder with OR logic
9. Connect the Pneumatic controls for Control of a double-acting cylinder with AND logic
10. Connect pneumatic devices and control the speed of a Double Acting Cylinder

Note: Exam should be conducted from the experiments in which students underwent training only as classes are conducted on a rotation basis.

State Board of Technical Education, Telangana State
SEE Model Paper
ME-508 – METROLOGY LAB PNEUMATICS LAB

Time: 2 Hour **Total Marks: 40 M**

Note: Answer any one question.

1. Measure the angle of the machined surface using a sine bar with slip gauges.
2. Measure the screw thread parameters such as pitch, thread angle, and depth of screw of a given specimen using Tool Maker's Microscope/Gear tooth vernier
3. Check the alignment of a given specimen using an Autocollimator.
4. Measure the displacement using LVDT.
5. Measure the surface roughness of a given surface using a Talysurf tester.
6. Connect pneumatic devices and control the direction of a Single Acting Cylinder
7. Connect pneumatic devices and control the direction of a Double Acting Cylinder
8. Connect the Pneumatic controls for Control of a double-acting cylinder with OR logic
9. Connect the Pneumatic controls for Control of a double-acting cylinder with AND logic
10. Connect pneumatic devices and control the speed of a Double Acting Cylinder

ME-509-REFRIGERATION AND AIR CONDITIONING LAB

Course Title	Refrigeration and Air Conditioning Lab	Course Code:	ME-509
Semester:	V	Course group :	Practical
Teaching Scheme(L:T:P):	1:0:2	Credits	1.25
Methodolgy :	Lecture + Assignment	Total contact periods:	45
CIE:	60 Marks	SEE:	40 Marks

Prerequisites: Basic knowledge of Thermodynamics and Refrigeration & Air conditioning

COURSE OUTCOMES

CO	**On Successful completion of the course, the student will be able to**
1	Summarize working of refrigeration and air conditioning system tools and perform basic operations on softcopper tube
2	Identify and acquire knowledge to handle different components of Refrigeration and Air Conditioning systems.
3	Classify refrigerants and justify their application.
4	Evaluate Coefficient of Performance (COP) of Refrigeration and Air conditioning system with given data and validate the result by using p-hchart.
5	Determine Coefficient of Performance (COP) of Refrigeration and Air conditioning systems
6	Illustrate working of air cooler, water cooler, domestic refrigerator, split air Conditioner and window air conditioner and sketch the flow diagram.

Course Content and Blue Print of Marks for SEE

	Unit name	Hours/ Periods	Marks for SEE			Marks weightage	%Weightage
			Handling	Manipulation	Precision		
1.	R&AC Tools, Basic Operations on soft Coppertube	3	10	15	15	40	100
2.	Vapour Compression cycle testrig	6	10	15	15	40	100
3.	Water cooler	6	10	15	15	40	100
4	Air conditioning test rig	6	10	15	15	40	100
5	Domestic refrigerator	6	10	15	15	40	100
6	Window air conditioner	6	10	15	15	40	100
7	Split air conditioner	6	10	15	15	40	100
8	Air cooler	6	10	15	15	40	100
	TOTAL	45					

CO-PO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	0.00	0.00	1.50	1.50	0.00	0.00	0.00
CO2	3.00	3.00	1.50	1.50	3.00	3.00	1.50
CO3	1.50	3.00	3.00	3.00	1.50	3.00	3.00
CO4	1.50	0.00	0.00	0.00	0.00	0.00	0.00
CO5	1.50	0.00	3.00	3.00	1.50	1.50	3.00
CO6	3.00	0.00	3.00	3.00	1.50	1.50	3.00
AVERAGE	1.75	1.00	2.00	2.00	1.25	1.50	1.75

CO-PO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	-	3	1	-	2
CO2	2	-	1	2	1	-	3
CO3	2	-	-	2	1	-	2
CO4	2	1	1	2	-	-	3
CO5	2	1	1	2	1	-	2
CO6	1	-	-	2	2	-	2

COURSE OUTCOMES		CL	Linked POs
CO1	Evaluate Refrigeration and Air conditioning system tools and basic operations on soft copper tube	R, U, A	1,4,5,7
CO2	Identify and acquire knowledge on working of different parts of Refrigeration and Air conditioning systems.	R, U, A	1,3,4,5,7
CO3	Develop knowledge on refrigerants.	R, U, A	1,4,5,7
CO4	Measure Coefficient of Performance(COP) of Refrigeration and Air conditioning system withgiven data and use p-h chart.	U, A	1,2,3,4,7
CO5	Determine Coefficient of Performance(COP) of Refrigeration and Air conditioning systems systems.	U, A	1,2,3,4,7
CO6	Distinguish working of air cooler, water cooler, domesticrefrigerator,splitairconditionerandwindow air conditioner.	R, U, A	1,4,5,7

ME-509

BOARD DIPLOMA EXAMINATIONS (C24)
Model Paper MID SEM - I
DME V SEMESTER EXAMINATION
REFRIGERATION AND AIR CONDITIONING LAB

TIME :1 Hours Max. Marks: 20

Answer any one question

1. List all basic tools used in RAC and identifythem
2. Perform flaring and swaging operation on coppertube.
3. Perform brazing operation on given coppertube.
4. Determine COP of Vapour compression cycle from given datanumerically
5. Determine COP of Vapour compression cycle from given data using p-hchart.
6. Identify all parts of water cooler and explain theirfunction.
7. Determine COP of air conditioning test rig from given datanumerically

ME-509

BOARD DIPLOMA EXAMINATIONS (C21)
Model Paper MID SEM - II
DME V SEMESTEREXAMINATION
REFRIGERATION AND AIR CONDITIONING LAB

TIME :1 Hours Max. Marks: 20

Answer any one question

1. Identify all parts of domestic refrigerator and explain theirfunction.
2. Determine COP of domestic refrigerator from P-hdiagram.
3. Identify all major parts of window air conditioner and explain theirfunction.
4. Identify all major parts of split air conditioner and explain theirfunction.
5. Identify all major parts of window air conditioner and explain their function, record the change in temperature of room for every 5minutes.

BOARD DIPLOMA EXAMINATIONS (C24)
Model Paper (SEE)
DME V SEMESTER EXAMINATION
REFRIGERATION AND AIR CONDITIONING LAB

TIME :2 Hours Max. Marks: 40

Answer any one question

1. List out all basic tools used in Refrigeration and Air conditioning system. Identifythe tools and perform flaring and swaging operation on coppertube
2. List out all basic tools used in Refrigeration and Air conditioning systems. Identifythe tools and perform brazing and swaging operation on coppertube
3. Determine COP of Vapour compression cycle from given datanumerically
4. Determine COP of Vapour compression cycle from given data using p-hchart.
5. Determine COP of Vapour compression cycle from experimentaldata
6. Determine COP of water cooler from experimentaldata.
7. Determine COP of domestic refrigerator from experimentaldata.
8. Determine COP of air conditioning test rig from experimentaldata.
9. Identify all major parts of window air conditioner and explain theirfunction.
10. Identify all major parts of split air conditioner and explain theirfunction.
11. Identify all major parts of window air conditioner and explain their function, record the change in temperature of room for every 5minutes.

SEE Question paper has to be prepared by Internal and External Examiners together.

ME-510 – PROJECT WORK

Course Title	Project Work	Course Code	ME-510
Semester	V	Course Group	Practical
Teaching Scheme in Periods(L:T:P)	1:0:2	Credits	1.25
Methodology	Practical	Total Contact Periods	45
CIE	60 Marks	SEE	40 Marks

Course out comes:

The student should be able to

1. Apply principles of Mining Engineering to solve real world problems
2. Demonstrate the knowledge and skills to assess safety, legal issues and consequentresponsibilities.
3. To function effectively as an individual and as a member in a team
4. To communicate and collaborate effectively with the team
5. To engage in lifelong learning in the context of technological changes

S. No	Subject	Duration	Items	Max Marks	Remarks
1	PROJECT		1.project I spell (Abstract submission)	25	
			2. project II spell (Final submission)	25	
			3.a)Maintenance of Log Book	15	
			b)Record work	15	
			4.a) Seminar	10	
			b) Viva Voce	10	
Total :				100	

The Project shall carry 100 marks and pass marks is 50% a candidate failing to secure the minimum marks should repeat the Project work.

Thrust areas identified for Project work

According to the local needs, the following major projects are suggested:

1. Open cast Mining
2. Mine Machineries
3. Mine Environmental Engg.
4. Mine Ventilation
5. Mine Disasters
6. Mining Geology
7. Mine Surveying
8. Underground Metaliferrous Mining
9. Advanced Open cast Machineries
10. Any concerned mining Projects
11. Rock Mechanics and Ground control
12. Controlled blasting techniques

Project report

The Project Report should consist of following items.

1. Introduction
2. Review of Literature
3. Study Area
4. Methodology/Design/fabrication/Tests
5. Result and Discussion
6. Conclusion and scope for future study
7. References.

Standards of the Project Report

1. Project reports should be typed neatly in Times New Roman letters with
   (a) Font size 14 for titles
   (b) Font size 12 for text on both sides of the paper
   (c) 1.5 line spacing on a A4 size paper (210 x 297 mm)
   (d) The margins should be: Left - 1.5", Right - 1", Top and Bottom - 0.75". 2.

2. Total number of reports (Soft bound) to be prepared is:
   (a) One copy to the department /library
   (b) One copy to the concerned guide(s)
   (c) One copy to the candidate.
   (d) One copy to the Industrial training Officer

3. Before taking the final printout, the approval of the concerned guide(s) is mandatory and suggested corrections, if any, must be incorporated.

4. Every copy of the report must contain
    a. Inner title page (White)
    b. Outer title page with a plastic cover
    c. Candidate declaration and Certificate in the format enclosed both from the institution and the organization where the project is carried out.

5. An abstract (synopsis) not exceeding 100 words, indicating salient features of the work.

6. Chapters(to be numbered in Arabic) containing

Introduction which usually specifies the scope of work and its importance and relation to previous work and the present developments.

Main body of the report divided appropriately into chapters, sections and subsections.

The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc. The chapter must be left or right justified (font size 16). Followed by the title of chapter centered (font size 18), section/subsection numbers along with their headings must beleft justified with section number and its heading in font size 16 and subsection and its heading in font size 14.

The body or the text of the report should have font size 12. The figures and tables must be numbered chapter wise

The last chapter should contain the summary of the work carried, contributions if any, their utility along with the scope for further work.

Reference or Bibliography: The references should be numbered serially in the order of their occurrence in the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order.