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HEATING VENTILATION AIR CONDITIONING **Course Code : 315373**

Programme Name/s : **Mechanical Engineering**
Programme Code : **ME**
Semester : **Fifth**
Course Title : **HEATING VENTILATION AIR CONDITIONING**
Course Code : **315373**

I. RATIONALE

Diploma Engineers must know the HVAC (Heating Ventilation Air Conditioning) systems due to the popularity and expansion of HVAC used in residential, commercial and industrial settings as well as the challenges involved with it. They should be familiar with the techniques, tools and systems used in heating, ventilation and air conditioning to maintain and modify the current needs. HVAC systems are crucial for ensuring comfort, safety, sustainability and efficiency in both residential and commercial applications. Therefore, this course is designed to provide knowledge & skills related to HVAC.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Choose appropriate Heating, Ventilation and Air-Conditioning systems and its components based on the requirement / field applications economically.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply Psychrometric principles for HVAC applications.
- CO2 - Select appropriate components for given HVAC applications.
- CO3 - Select appropriate Air conditioning systems for given situation.
- CO4 - Calculate cooling load for the particular situation.
- CO5 - Develop proper Air distribution systems according to site requirement for the given situation.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315373	HEATING VENTILATION AIR CONDITIONING	HVA	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

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Total IKS Hrs for Sem. : 2 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Draw various psychrometric processes on psychrometric chart for given Air properties. TLO 1.2 Calculate air properties by using Psychrometry for given data. TLO 1.3 Explain the factors affecting the thermal comfort of human body. TLO 1.4 Explain the strategies for improving indoor air quality. TLO 1.5 Explain outdoor design conditions for occupants in given situation.	**Unit - I Applied Psychrometry** 1.1 Introduction to Air cooling, Concept of Heat Pump. 1.2 Psychrometric Chart: Psychrometric properties of air, Psychrometric processes using By-Pass factor(BPF), Apparatus Dew Point (ADP), Sensible Heat Factor (SHF) and adiabatic mixing of two air streams (Simple numericals on Psychrometry). 1.3 Thermal Comfort: Basic parameters, Thermodynamics of human body, Thermal comfort and Comfort charts, Factors affecting thermal comforts. 1.4 Indoor Air Quality (IAQ): Indoor air contaminants, Basic strategies to improve indoor air quality. 1.5 Outdoor Design Conditions: Outdoor air requirements for occupants, Use of outdoor weather data in design, Outdoor weather characteristics and their influence.	Lecture Using Chalk-Board Presentations Videos Collaborative learning

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Classify compressor used in HVAC system. TLO 2.2 Explain the working of any two components of HVAC system. TLO 2.3 Explain the working of any two auxiliary devices used in HVAC system.	**Unit - II Cooling System Components** 2.1 Refrigeration Compressors: Classifications, Construction and working of Hermetically sealed air compressor, Open type compressor, Rotary compressor, Centrifugal compressor, Screw and Scroll compressor and their applications. 2.2 Condensers: Classifications, Working of Air and Water-cooled condensers, Evaporative condensers, comparisons and applications. 2.3 Evaporators: Classification, Working & Applications of- finned type, Bared tube, Plate type, Flooded, Shell and Tube type evaporators. 2.4 Expansion devices: Classification, Capillary tube, Automatic expansion valve, Thermostatic expansion valve, their selection, working and application.	Lecture Using Chalk-Board Presentations Videos Collaborative learning
3	TLO 3.1 Classify Air conditioning system. TLO 3.2 Explain working of any one Air conditioning system. TLO 3.3 Explain the working of Cassette air conditioning system. TLO 3.4 Explain the constructional features of Central air conditioning. TLO 3.5 Select relevant components for given Air conditioning system. TLO 3.6 Select the insulating materials for given Air conditioning system. TLO 3.7 Describe the air conditioning maintenance procedure.	**Unit - III Air Conditioning Systems** 3.1 Classification of Air conditioning System- Summer and Winter, Year around air conditioning, Unitary air conditioning construction, application & comparison. 3.2 Construction and working of Cassette air conditioning system. 3.3 Central air conditioning- types, Direct and Indirect central air conditioning construction, application. 3.4 Insulations- Purpose, types of insulation, materials and their properties. 3.5 Heating Coils- Types 3.6 Introduction to Automobile Air conditioning system. 3.7 Basic requirements for Installation, testing of HVAC Systems, selection of appropriate Air conditioning systems for given situation with justification.	Lecture Using Chalk-Board Presentations Videos Collaborative learning Hands on experience on different test rigs/ prototype
4	TLO 4.1 List the factors to be considered for cooling load calculations. TLO 4.2 Identify the sources of heat gain in Air Conditioning system for the given situation with justification. TLO 4.3 Calculate cooling load for the given situation.	**Unit - IV Cooling Load Calculations** 4.1 Introduction & necessity of Cooling Load Calculations- Energy Efficiency, System Sizing, Occupant Comfort. 4.2 Factors to be considered for cooling load calculations. 4.3 Calculation of Sensible and Latent heat gain sources. 4.4 Cooling load calculation for- Auditorium/ Computer laboratory/ Class room.	Lecture Using Chalk-Board Presentations Videos Collaborative learning Hands on experience

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain the principles of Ventilation including Natural and Mechanical ventilation systems. TLO 5.2 Describe different types of air distribution systems. TLO 5.3 List the design criteria for duct system. TLO 5.4 Select appropriate components for an air distribution system. TLO 5.5 Describe design criteria for Air distribution system in given situation.	**Unit - V Ventilation, Infiltration & Air Distribution Systems** 5.1 Ventilation and Infiltration: Natural ventilation, Mechanical ventilation, Concept of Basement Ventilation, Heat Sensors. 5.2 Concept of Air handling unit, Air distribution system- Closed perimeter system, Extended perimeter system, Radial duct system, construction and application of Supply, Return and Make up ducts. 5.3 Duct Design: Definition of duct and types of ducts, Economic factors influencing duct layout, Materials for ducts and its specification, Flow through duct, Pressure in ducts, losses in ducts, Equivalent diameter of a circular duct for rectangular sections, Factors considered for duct design. (Simple numericals on duct design). 5.4 Air Distribution System: : Factors to be considered for Air distribution system, Types of Air distribution devices. Types of Fans used in air conditioning applications, Types of Supply air outlets, Selection and location of Outlets, Filters, Diffusers, Grills, Blowers and Dampers. Air jet nozzles, Concept of Variable Air Volume (VAV) systems and working.	Chalk-Board Presentations Videos Collaborative learning Hands on experience

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Measure air properties using appropriate Psychrometer efficiently. LLO 1.2 Calculate various air properties using Psychrometeric Chart.	1	*Measurement of air properties.	2	CO1
LLO 2.1 Identify the components of a Unitary Air conditioner. LLO 2.2 Make use of manufacturer catalogue for specifications and ratings for each component.	2	*Identification of various components of Unitary Air conditioning system with specifications.	2	CO2
LLO 3.1 Select the proper tools for dismantling and assembling. LLO 3.2 Inspect condition of components.	3	Dismantling & assembling of the Cassette air conditioning system.	2	CO2 CO3
LLO 4.1 Identify the components of a Central Air Conditioning system. LLO 4.2 Demonstrate the Central Air Conditioning system.	4	Demonstration on Central Air conditioner system.	2	CO2 CO3
LLO 5.1 Select the proper tools for dismantling and assembling. LLO 5.2 Inspect condition of components.	5	Dismantling & assembling of Automobile Air conditioner.	2	CO2 CO3
LLO 6.1 Conduct performance test on Air Conditioning Test rig to evaluate the cooling effect. LLO 6.2 Measure and record parameters such as supply air temperature, return air temperature, outdoor air temperature and humidity levels.	6	*Trial on Air conditioning system.	2	CO4
LLO 7.1 Analyze the specific thermal loads and environmental conditions of a specific space. LLO 7.2 Calculate heat gains and losses.	7	*Cooling and heating load calculations.	2	CO4

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Prepare Air distribution system layout. LLO 8.2 Create schematic layouts by using Auto-CAD that illustrate the proposed duct routes, sizes, and connections.	8	*Prepare layout of Air distribution system of given space.	2	CO4 CO5
LLO 9.1 Identify the components of a railway HVAC system. LLO 9.2 Demonstrate the railway HVAC system.	9	Demonstration on railway HVAC system.	2	CO3 CO5
LLO 10.1 Identify the components of Air conditioning system used in ancient India. LLO 10.2 Prepare a report on Air conditioning system used in ancient India.	10	Air conditioning system used in ancient India. (IKS)	2	CO1 CO2 CO3 CO4 CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Measurement of air properties. Psychrometeric Chart with Digital Psychrometer/ Sling Psychrometer/Wall mounted Psychrometer/: Temperature measurement : range/accuracy/resolution: -4°to122°F (-20° to 50°C)/ ±1.8°F (±1°C)/0.1° Humidity measurement range/resolution: 0 to 100%RH/0.1% Humidity measurement accuracy: ±3% of reading from 10 to 90%RH; ±4% Dew point measurement range/accuracy: -47° to 122°F/±1.2°F (±0.6°C) Response time: 60 seconds (typical) Readout sizes: 3/8 in. high digits on upper readout; 3/16 in. high digits on lower readout Auto power off: 20 minutes of inactivity Weight: 2.65 oz. (75g) Power source: Two "AAA" batteries (included)	1
2	Identification of various components of Unitary Air conditioner with specifications. Cooling Capacity: Min 1 TR or more.	2
3	Dismantling & assembling of the Cassette air conditioning system. Cooling Capacity: Min 1 TR or more.	3
4	Demonstration on Central Air conditioner system. Cooling Capacity: Min 10 TR or more.	4
5	Dismantling & assembling of Automobile Air conditioner. Automobile AC Compressor, Capacity: 10 - 1000 CFM or more.	5
6	Experimental set up of Air conditioning system. Cooling Capacity: Min 1.5 TR or more.	6

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
7	Cooling and heating load calculations. Lux meter: MAX / MIN, Backlight, Auto Power Off. Range: 0 ~ 100,000 lux / 0 ~20,000 Accuracy: ± 5% rdg + 10 dgt (< 10.000 lux / fc) ± 10% rdg + 10 dgt (>10.000 lux/fc) Resolution: 0.1 lux or 0.1 fc. Anemometer: Temperature Range: -20.0~60.0ºC Humidity Range (Rh %): 0.0% ~ 99.9 % RH Range: 0.70~30.00 m/s	7
8	Prepare layout of Air distribution system of given space. Educational version license of Auto-CAD or as per availability.	8
9	Demonstration on railway HVAC system. By using available Interactive Classroom Techniques.	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Applied Psychrometry	CO1	6	2	4	4	10
2	II	Cooling System Components	CO2	8	2	4	8	14
3	III	Air Conditioning Systems	CO3	10	2	8	6	16
4	IV	Cooling Load Calculations	CO4	6	2	4	6	12
5	V	Ventilation, Infiltration & Air Distribution Systems	CO5	10	2	4	12	18
Grand Total				**40**	**10**	**24**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks and average of two-unit tests.

For laboratory learning 25 Marks.

Summative Assessment (Assessment of Learning)

- End semester assessment of 25 marks for laboratory learning.

End semester assessment of 70 marks.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	-	3	2	3	2			
CO2	3	2	-	2	-	3	2			

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CO3	3	2	-	2	-	3	2			
CO4	3	3	-	2	3	3	2			
CO5	3	2	3	3	3	3	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Khurmi R.S.& J.K.Gupta	Refrigeration and Air Conditioning	S. Chand publication, New Delhi,(2008), ISBN-10:8121927811
2	Arora C.P.	Refrigeration and Air Conditioning	Tata McGraw-Hill Publication, New Delhi, (2009), ISBN-13-978-07-008390-5
3	Ananthnarayan P.M	Basic Refrigeration and Air Conditioning	Tata McGraw-Hill Publication, New Delhi, (2013), ISBN- 9781259062704
4	Sapali S. N.	Refrigeration and Air Conditioning	PHI publication, New Delhi, (2013) ISBN - 9788120348721
5	Prasad Manohar	Refrigeration and Air Conditioning	New Age International, New Delhi, (2011), ISBN-9788122414295
6	R.K.Rajput	Refrigeration and Air Conditioning	S.K.Kataria & Sons, New Delhi, (2018) ISBN- 13-9788188458400
7	Dossat R.J.	Principles of Refrigeration	John Wiley and Sons Ltd, UK, (2009) ISBN 978-0130272706

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/YoN5251ta18?si=7t18E4M3uUVgJ_r4	Basic Concepts of Psychrometry and Air-Conditioning
2	https://youtu.be/WM09L5aUuyE?si=rX8vNmF3nxCDOTM-	Fundamentals of Thermal Comfort
3	https://youtu.be/NpaR7x-caAo?si=1Sg1Uz0kRwpua_9r	Indoor Air Quality
4	https://youtu.be/yqpR7udHBEA?si=CXsKDKAWaHemwGOA	Outdoor Design Conditions
5	https://youtu.be/YUgN5D-bmpg?si=x6nxT3cwdxwze2mc	Air-Conditioning Systems
6	https://youtu.be/tNj8ocNO4iw?si=_cvQGVSwOOo1jXH6	working of Cassette air conditioning system
7	https://youtu.be/xMkgzVR1Luo?si=uyDAtROjjxnMg7MT	Introduction to HVAC
8	https://youtu.be/rTBoP8LbTJA?si=2DCzHNZ3E3rJbEhU	Cooling Load Calculation
9	https://youtu.be/gRcgUfeAHl4?si=5l0EdmQDsYXGy2Q_	Air Distribution System-1
10	https://youtu.be/7Kd3p-xDT2U?si=Ek-Z2yyg9g24I7NE	Air Distribution System-2
11	https://youtu.be/BNl638zbWRQ?si=4Mes8896maK3_n3Z	Variable Air Volume (VAV) systems and working.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students