

2. CURRICULUM

| Sl. No. | Code | Title | No. of Lecture Hours |
|---------------------------|----------------------|--|-----------------------------|
| 1 | RAC 001 | Fundamentals of Refrigeration and Air conditioning | 60 |
| 2 | RAC 002 | Psychrometry, Heat load Estimation for Air conditioning and Refrigeration Applications | 70 |
| 3 | RAC 003 | Selection of Refrigeration and Air conditioning Systems | 30 |
| 4 | RAC 004 | Auxiliary Systems and components for R&AC applications | 140 |
| 5 | RAC 005 | Installation, Testing and commissioning and Management aspects of HVAC&R Projects | 60 |
| 6 | RAC 006 – PART A & B | On-site Training | 120* |
| Total Contact hour | | | 480 h |

Note : * The Onsite Training has two slots.

RAC 006 – Part A : One week (20 h) after RAC 001 - Visit to HVAC Project site to identify the equipment's, Nomenclature that are commonly used in the Industry.

RAC 006 – Part B – Three weeks after all the theory modules.

3. SYLLABUS – R 2015-16

| RAC 001 | Fundamentals of Refrigeration and Air conditioning | Period (h) |
|---------|---|------------|
| | <p>Introduction</p> <p>Units and Conversion, Definition and Applications of Refrigeration and Air conditioning: Air conditioning, Cold Storage, Process cooling, Transport refrigeration etc.</p> | 4 |
| | <p>Thermal Principles</p> <p>Thermodynamics: Concepts, Laws, Phase diagram, Open and closed systems</p> | 2 |
| | <p>Heat and Mass transfer</p> <p>Heat, Sensible and latent heat definition, Concepts of conduction, convection, radiation, Boiling and condensation heat transfer – Simple problems</p> | 3 |
| | <p>Fluid Mechanics</p> <p>Types and properties of fluids, Laminar and Turbulent Flows, Pressure head, Bernoulli's theorem, Flow measurements, Pressure drop calculations, Power transmission through pipes and ducts</p> | 4 |
| | <p>Refrigeration cycle</p> <p>Unit of refrigeration, Refrigerating effect, Carnot COP - Refrigerator & heat pumps, Limitations of Carnot cycle</p> | 2 |
| | <p>Refrigerants</p> <p>Definition, Nomenclature, Classification, Essential and Desirable Properties, ODP, GWP & TEWI – and other Environmental issues</p> | 3 |
| | <p>Refrigeration cycle</p> <p>Simple vapour compression – Ph-TS diagram, COP, Heat rejection ratio, different processes, Effect of sub cooling and super heating, Effect of suction and discharge pressures on the cycle performance, Actual compression cycle – Simple problems with the use of Ph charts and Tables.</p> | 10 |
| | <p>Multistage systems</p> <p>Flash gas removal, multi evaporator, multistage compression, cascade systems – Concepts only</p> | 2 |

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| | <p>Other cycles</p> <p>Vapour absorption and adsorption systems, steam jet, Thermoelectric etc.- concepts only</p> <p>Components</p> <p>Compressor : Types and classification of compressors, Constructional details and working of reciprocating, rotary, centrifugal, screw, scroll compressors, Selection of compressors for different applications, capacity control and performance comparison.</p> <p>Condenser: Types and working of different condensers, Air cooled condensers, Water cooled condensers - shell and tube, shell and coil, double pipe, evaporative – Heat transfer estimation – Selection and application - fouling factors and factors affecting condenser performance.</p> <p>Evaporators : Types of evaporators, DX, flooded, finned, plate, falling film – heat transfer estimation – selection and application, factors affecting evaporator performance</p> <p>Expansion Devices: Types of expansion devices – capillary, TEV, EEV, Automatic EV, Float valve, orifice and distributors – Selection and application - Performance</p> <p>Auxiliary components: Solenoid valves, filters, dryers, relief valve, back pressure valves, accumulators, HP, LP and OP controls, receivers, oil separators, oil coolers, purge valves, Temperature and humidity controls.</p> <p>Overall Systems</p> <p>Air side loop, Chilled water loop, Refrigeration loop, heat rejection loop and control loop</p> | <p>4</p> <p>4</p> <p>4</p> <p>4</p> <p>4</p> <p>4</p> <p>2</p> |
| | <p>Assessment Test (MCQ only)</p> | <p>2</p> |
| | <p>Total :</p> | <p>60 h</p> |

| RAC 002 | Psychrometry, Heat load Estimation for AC and refrigeration | Period (h) |
|---------|---|---|
| | <p>Psychrometry</p> <p>Definition of Psychrometric terms, Air-water mixtures properties – Use of Psychrometric Chart, Various Psychrometric processes – 6 processes, mixing, air washers, Bypass factors of coil load calculations, SHR, LHR, THR and Determination of ADP, Enthalpy Calculations and exercises, Plotting of air conditioning processes in chart.</p> <p>Thermal comfort</p> <p>Factors affecting human comfort, Comfort parameters, Comfort chart, ASHRAE Standards 55</p> <p>Heat load Design data</p> <p>Location, Weather data, Orientation, Solar Radiation - U factors and shading coefficients of building envelopes, Heat Gain through envelopes – Infiltration and ventilation loads – outside and inside design conditions, Internal loads</p> <p>Heat load estimation</p> <p>Air conditioning :</p> <p>Data collection for Heat load: equivalent temperature difference, daily range etc., Study of Drawings, Procedure for heating and cooling load estimation: Dehumidified air quantity, ETH, ESHF, GTH, Interpretation of heat load estimations and hands on exercise.</p> <p>Refrigeration :</p> <p>Cooling load calculation for cold storages: Product storage temperatures, Design input data : respiration load, pull down time, infiltration, daily loading, internal loads, U – factors for thermal envelope etc. Procedures for estimation of cooling load, hands on exercise</p> | <p>25</p> <p>3</p> <p>8</p> <p>20</p> <p>10</p> |
| | <p>Assessment (Descriptive Problem type)</p> | <p>4</p> |
| | <p style="text-align: right;">Total</p> | <p>70 h</p> |

| RAC 003 | Selection of Refrigeration and Air conditioning Systems | Period (h) |
|----------------|---|---|
| | <p>Air conditioning systems Selection of systems for different Applications: Residential, Commercial – Hotels, Mall, Hospitals, Industrial etc. Window, Ductless split ACs, Package and Ductable units, VRFs/VRV, large DX systems with AHUs, Air cooled and water cooled condensing units</p> <p>Chilled water systems Air and water cooled chillers – compressors, types and capacities range and applications,</p> <p>Air Loop AHUs - Single, multi zone systems, terminal reheat systems, Dual duct systems</p> <p>Chilled water loop Chilled water distribution - constant volume, constant primary – variable secondary, variable primary flow, tertiary pumping systems, chilled water cooling coils for various applications, Piping – Direct return and reverse return, district cooling piping systems (concept only)</p> <p>Refrigeration and heat rejection loop Air cooled, water cooled – condensing units, compressors and condensers – Cooling towers</p> <p>Procedures for Selection of Equipment DX Systems: AHUs with cooling coils and expansion device Condensing units, Selection of equipment's for cold storages and other allied components.</p> <p>Chilled water systems: Chillers, AHUs, Pumps, Fans, Cooling towers and other allied components</p> | <p>4</p> <p>1</p> <p>3</p> <p>4</p> <p>2</p> <p>2</p> <p>12</p> |
| | Assessment (MCQ) | 2 |
| | Total | 30 h |

| RAC 004 | Auxiliary Systems and components for R&AC applications | Period (h) |
|---------|---|------------|
| | <p>Air distribution</p> <p>Study of Architectural / structural layout of interiors, Location of AHUs, Duct design methodologies, Different types of duct design, Selection of air terminals, dampers, filters etc. Pressure drop estimation, Constant volume systems, variable air volume systems, VAV boxes, Single duct cooling and heating, VAV with parallel and series fan powered, induction VAVs, accessories involved, Hands on exercises.</p> | 35 |
| | <p>Types of Room air Distribution Systems: Mixing Air, Displacement, Unidirectional and Under-Floor.</p> | 5 |
| | <p>Fan</p> <p>Law, Types including ventilation, Selection of fan for various applications, Power, Efficiency, Motor sizing, Noise level, Static pressure, operation and performance issues, Hands on exercises</p> | 8 |
| | <p>Piping design</p> <p>Water : Open and closed piping systems, Piping routing, pipe sizing – flow, velocity, pressure drop, Accessories - expansion / make up water tank, Valves and fittings, Calculation of total pressure drop across the piping circuit, Chemical dosing, NPSH calculations, pressure testing parameters, Hands on exercises.</p> | 24 |
| | <p>Refrigerant : Criteria for sizing suction, liquid, hot gas line, pressure drop, oil return, schematic layout of systems, and best practices, pressure testing parameters, Accessories, Hands on exercises</p> | 10 |
| | <p>Pump and Pumping systems</p> <p>Chilled and cooling water – Types, Selection, Head Requirement, Motor sizing, Operation and Performance issues</p> | 8 |
| | <p>Electrical Fundamentals</p> <p>Preparation of single line diagram, Motors, Controllers, Types of Starters, VFD etc – Selection, Operation, Part load Behavior and Performance Rating, MCC layout, Cabling and earthing, control wiring, Selection of starters and breakers</p> | 12 |
| | <p>Electrical Control and BMS</p> <p>Fundamentals of Control, Types of controllers, Control systems applicable to Chillers, VRF etc., BMS, Introduction to BACnet</p> | 14 |

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| | <p>Basement ventilation, staircase, lift pressurization systems</p> <p>Requirement as per NBC Code, Fans Selections – Jet, Axial, PLC systems, CO sensors etc.</p> <p>Recent Advances</p> <p>Energy Simulation, ECBC codes and its impact, Green Buildings, LEED Certification, Evaporative cooling, radiant cooling systems etc.</p> <p>Other systems:</p> <p>Concepts of Water treatment, Chemical treatment, Fire protection and safety</p> | <p>4</p> <p>10</p> <p>8</p> |
| | <p>Assessment (MCQ)</p> | <p>2</p> |
| | <p>Total (h)</p> | <p>140</p> |

| RAC 005 | Installation, Testing and commissioning and Management aspects of HVAC&R Projects | Period (h) |
|---------|---|--|
| | <p>Installation</p> <p>Refrigeration and Air-conditioning plant layout, Parameters affecting the location, organizational approach. Erection methodology, foundation, padding, network analysis, critical path , interconnections, safety precautions, air handling equipment's, locations in the systems , corrosion , noise , vibration monitoring and control</p> <p>Testing of HVAC & R Systems</p> <p>Codes and Standards related to HVAC&R Projects, Instruments requirements – Pressure, Temperature, Flow, Air Quality, Power, Harmonics etc. General and specific testing and its procedures for constant air volume systems, variable air volume systems, return air systems, Cooling towers and performance, fans and fan performance</p> <p>Balancing of HVAC & R Systems</p> <p>HVAC systems, centrifugal pumps and pump performance, analog and digital controls and water balancing procedures using flow meters, system components, and temperatures</p> <p>HVAC & R Commissioning</p> <p>HVAC Commissioning Cost / Benefit Analysis, Selection of Commissioning Provider, The HVAC Commissioning Team Comprehensive HVAC Commissioning, Construction HVAC Commissioning, HVAC Commissioning in Existing Buildings</p> <p>Management Aspects</p> <p>Interpersonal Skills : Technical communication, Professional ethics</p> <p>Reading and Working on CAD drawings</p> <p>Preparation of Tender Estimation – Schedule of Quantities</p> <p>Project management – Procedure for execution of Jobs from concept to commissioning.</p> <p>Understanding and fulfilling of contractual obligations</p> <p>Discussion – Case Studies of Critical Projects highlighting Design challenges, Commissioning tasks etc.</p> | <p>8</p> <p>8</p> <p>8</p> <p>10</p> <p>24</p> |
| | Assessment (MCQ) | 2 |
| | Total (h) | 60 |

| RAC 006 | On-Site Training | Period (h) |
|----------------|--|-------------------|
| | <p>The students must be placed with a HVAC&R contracting, design or manufacturing organization for the period of 1 month – in two slots.</p> <p>One at after the RAC 001 for one week and other after all the theory modules for three weeks.</p> <p>He will be exposed to the different aspects of the project viz, study of drawing, selection of equipment's, design, installation, commissioning etc.</p> <p>One faculty as Guide will be allotted for a batch of 5 students and he will monitor their progress and student can interact with him for any doubts / clarifications during the training period.</p> <p>At the end of the training period, each student will have make presentation about the experiences gained during the training program.</p> <p>Evaluation for this training is based on two modes.</p> <p>10 Marks for the Guide (based on the interactions and report from the Industry where he got training)</p> <p>10 Marks for the Presentation</p> | <p>120</p> |