# FAIRCONDITIONING ENGINEERING STUDENT CERTIFICATE WORKSHOP REPORT

## Pune, 29 August – 2 September 2016


### Abstract

The Fairconditioning Program conducted a workshop titled *'Thoughtful Cooling – A Student Engineering Certificate Workshop'* to train students on different sustainable cooling technologies that can be used while designing buildings and to incorporate sustainability into the engineering curricula, at **Sinhgad College of Engineering (SCoE), Pune held from 29 August to 2 September 2016**. This report highlights the events carried out during the workshop, along with the learning's and feedback from the participants and the Fairconditioning team.

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# Executive Summary

The Indo-Swiss *Fairconditioning* programme organized its workshop on *'Thoughtful Cooling – A Student Engineering Certificate Workshop teaching How to Cool Interiors Efficiently and Sustainably'* for engineering students in Pune. The workshop was conducted at Sinhgad College of Engineering (SCoE) from the 29th August to 2nd September 2016, in accordance with specific Memorandums of Understanding (MoU) signed with these institutions.

59 students from fourth year of the mechanical engineering course from Sinhgad College of Engineering attended the student engineering certificate workshop. Four trainers conducted the workshop over a period of five days, emphasizing on the importance of integrating sustainability, with respect to cooling technologies in their curricula through an array of lectures and group activities. The students were also taken for a guided site visit, where they were shown how the buildings had incorporated the best passive designs and efficient cooling technologies.

The trainings are part of the Fairconditioning programme, and are designed to significantly improve awareness, knowledge and know-how across tomorrow's architecture and building engineering graduates in the field of energy efficiency.

Similar training workshops will be organized and targeted towards architecture and engineering colleges/universities across the cities of Delhi/NCR, Pune, Mumbai, Chennai, Jaipur and Bangalore over the course of the next two years.

The end goal of these workshops is to see energy efficiency being seamlessly integrated into the core curricula of architectural colleges and universities, so as to enrich the upcoming Indian workforce with graduates that will be able to handle the responsibility in India's quest for an energy efficient, sustainable building growth. It also aims to provide a linkage between the sustainable energy industry and students or academia.

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# 1. Introduction

Devised by Noe21 (Geneva) and cBalance Solutions Hub (Pune), Fairconditioning aims to help countries in the tropical regions of the world address their cooling demand with the highest level of energy efficiency and lowest carbon emissions. June 2013 marked the beginning of this program, with the Pilot phase focusing on phasing out air conditioners using synthetic (fluorinated) refrigerants having very high global warming potential and phasing in energy efficient ACs that use natural refrigerants (propane), having low global warming potential.

Presently, Fairconditioning aims to inculcate a culture of energy efficiency in the cooling of interiors in India – involving academia, large corporations and practitioners in the building services area.

Fairconditioning deploys four Projects to promote these objectives, each targeted at intervention groups who influence the perception of energy efficient technology and consumption patterns of a wide range of Indian industries and consumers:

1. Academic Curricula Integration Project - ACIP
2. Technology Adoption Project - TAP
3. Building Energy Modeling and Advisory Project - BEMAP
4. Corporate Thermal Policies Project – CTPP (Up by 2°)

# 2. Project Overview

## 1. The Academic Curricula Integration Project (ACIP)

The Academic Curricula Integration Project has been designed to enhance action-oriented understanding of sustainable cooling technologies (for engineering students) and efficient building design centered around Energy Conservation Building Code (ECBC) and other relevant sustainable design building guidelines (for architecture students) through workshops designed to facilitate a two-way process of learning as well as syllabus integration of these programmes. These future professionals armed with up-to-date knowledge will be capable of integrating cooling load reduction strategies and sustainable cooling systems and energy efficiency principles in their practice.

ACIP aims at an ambitious but realistic objective: In 5 years from now, leading architecture and building engineering curricula located in the 5 biggest urban areas of India will have integrated energy efficiency in the substance of their existing curricula.

After events such as the ones described below have been carried out, the ACIP team will carry a follow-up process with staff motivated to install elective courses on energy efficiency in 4th year curricula and to update the compulsory curricula for 2nd and 3rd year students (universities). Events are the visible part of this project designed to be followed with less visible but highly critical working relationships with staff motivated to bring and match best practices in the energy efficiency field with present student curricula.

Approached by the ACIP team, the head of department of Mechanical Engineering at Sinhgad College of Engineering, Pune appreciated the program's goal and was eager to be associated with the project. Memorandums of Understanding were signed with this college leading to the workshop activities described below.

## 2. Structure of the Project

The Academic Curricula Integration Project (ACIP) conducts workshops of two types: Training of Trainers (ToT) and Student Certificate Programmes. The goal of this program is to conduct these workshops across a minimum of 6 cities - Mumbai, Pune, Bangalore, Delhi/NCR, Chennai and Jaipur – over the next two years.

The programme unfolds in two fields of study and teaching: Architecture and Engineering (including both civil and mechanical engineering). Currently the working professionals, professors and fresh graduates are unaware of the best practices in Sustainable Cooling technologies, building construction techniques or sustainable architecture. With the booming real estate and construction sector, India requires people with such skills to move towards to a low energy footprint.

## 2.1. Strategy

Methods of designing and building energy efficient buildings in India are widely available, but the problem lies in the implementation of these techniques to actual practice. This primarily happens because this knowledge is far from being transmitted to the next generation of Indian architects and engineers. The Student Engineering Certificate workshop aims to bridge this gap, by implementing techniques of sustainable architecture in the core curricula of the colleges and universities. These events organized by Fairconditioning bring a selection of specialised practitioners to share their knowledge with college staff and with students. Specialists are either architects, consultants specialised in assisting architects with energy related issues, engineers specialised in indoor cooling, etc. They are selected by the Steering Committee for their knowledge as well as their capacity to share their passion in a pedagogically effective manner. When one touches upon several fields of activity (see detailed programme of events in annexes), three-day sessions are insufficient to teach new technologies and skills. However, these three days are sufficient to sensitize staff on new skills and to motivate them towards an inner-academy process leading to new electives and renewed curricula content.

# 3. Workshop Proceedings

## 3. Workshop Plan

A renowned Mechanical/Civil Engineering College (for its progressive teaching methods and vibrant faculty) is selected and approached, to make it the Project HUB College. Comprising of the project team, professors and department heads from the HUB College, a steering committee is created. This committee aids in the localization and customization of the training content in order to align it with the existing curricula that the colleges are affiliated with. After being approached as the HUB College a Memorandum of Understanding is signed, to affirm their intent to support the curricula upgrading and measuring the level of integration of sustainability in the minds of the students through frequent assessments. Students for this workshop were selected on the basis of their performance in a test (conducted prior to the workshop by the college) and their interest.

### 3.1. Pre-Workshop Knowledge Dissemination

Themes of sustainable cooling technologies, building physics, thermal comfort and energy modelling were covered during the workshop. All modules and sessions were designed to encompass the aforementioned themes. Furthermore, trainers were provided with a brief, which included the guidelines, limitations and the basic agenda of the workshop to ensure that the delivery was relevant and effective.

### 3.2. Workshop Activities

Topics covered over the five days of the Student Engineering Certificate workshop involved a basic introduction to Climate Justice and Built Space, followed by an introduction to the Fairconditioning program. Students were also made to debate on the topics of their personal position in mapping and articulating in the context of Climate Change. Topics covered during this workshop included Building Physics, Thermal Comfort and Indoor Air Quality, Active Cooling, Natural Refrigerant Air Conditioning, Solar Vapour Absorption Machines, Direct/Indirect Evaporative Cooling, Structure and Radiant Cooling. The 3$^{rd}$ and 4$^{th}$ days focused on introducing Energy Modelling and Understanding the Smart Energy Tool to students. The site visit was held at Suzlon One Earth, Hadapsar on the 5$^{th}$ day of the workshop. This iconic building is an excellent example of sustainable construction, being self-sufficient, employing effective controls and building management systems for minimal harm done to the natural ecology of the site. Suzlon One Earth is a LEED Platinum and GRIHA 5 certified building, being one of the greenest corporate campuses in the world. The following are a list of the green features available at the site: 1) 100% powered by on-site and off-site renewable energy including hybrid wind turbines, solar panels and photovoltaic cells, 2) Rainwater harvesting facilities with on-site water treatment and recycling facilities 3) On-site organic waste converter 4) ‘Office in garden’ design concept which harvests maximum daylight in work spaces and common areas 5) Reduction of approximately 35% in operating cost due to energy and water cost savings, a benefit that is transferred to customers through increased investment in technology. Post site visit, students were evaluated, and on the basis of their performance they were granted certificates. Students that scored 50% and above, were handed a certificate of completion. Extensive online feedback forms were also shared with the participants, in order to analyse and comprehend their opinion on the organisational and

content relevance of the workshop. This feedback would be used to improve future workshops.

Photographs taken during the workshop are available on our Facebook page here.

### 3.3. Post-Workshop Follow Up

Post-workshop follow-ups involve getting the student body in touch with our advisory board members and their respective organisations with the prospect of providing them with an internship in the field of sustainable cooling.

## 4. Workshop Stakeholders

### 4.1. Trainers

**Table 1. Detailed list of the sessions conducted and the name and designation of the trainers.**

| Trainer | Sessions Conducted | Designation/ Organization |
|---|---|---|
| Anubhav Saxena | Introduction to Energy Modelling, Smart Energy Tool – Modelling Sustainable Cooling Technologies | Sustainability Project Consultant, AECOM |
| Mihir Shah | Case Study Detailing | CEO, Halston Software |
| Shrikant Kaduskar | Radiant Cooling | Owner, EMAC Services |
| Vrajalal Kanetkar | Evaporative Cooling | Engineer, Professor |
| Vivek Gilani | Climate Justice and the Built Space, Building Physics, Thermal Comfort and Indoor Air Quality, Active Cooling, Natural Refrigerants, Solar Vapour Absorption Machines, Direct/Indirect Evaporative Cooling, Structure and Radiant Cooling | Managing Director, cBalance Solutions |

## 4.2. Trainees

**Table 2. List of the participants and their respective colleges.**

| Name of Participant | College |
|---|---|
| Abhishek Gopane | Sinhgad College of Engineering |
| Abhishek Naik | Sinhgad College of Engineering |
| Adhav Adesh | Sinhgad College of Engineering |
| Aditya Salunkhe | Sinhgad College of Engineering |
| Ajinkya Bhosale | Sinhgad College of Engineering |
| Amar Giradkar | Sinhgad College of Engineering |
| Amit Jaid | Sinhgad College of Engineering |
| Arif Sayyed | Sinhgad College of Engineering |
| Ashish Takale | Sinhgad College of Engineering |
| Bandu Nagalbone | Sinhgad College of Engineering |
| Chandrashekhar Pedankar | Sinhgad College of Engineering |
| Divya Sakhare | Sinhgad College of Engineering |
| Dnyaneshwar Warwade | Sinhgad College of Engineering |
| Fardinkhan Pathan | Sinhgad College of Engineering |
| Ganesh Nagalgave | Sinhgad College of Engineering |
| Gaurav Ghule | Sinhgad College of Engineering |
| Gaurav Shinde | Sinhgad College of Engineering |
| Gaurav Sonawane | Sinhgad College of Engineering |

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|---|---|
| Gurudatta Gawatre | Sinhgad College of Engineering |
| Kiran Nikalje | Sinhgad College of Engineering |
| Kshitij Sonawane | Sinhgad College of Engineering |
| Mayuresh Khedkar | Sinhgad College of Engineering |
| Nihal Mulla | Sinhgad College of Engineering |
| Nilesh Kokate | Sinhgad College of Engineering |
| Onkar Lanke | Sinhgad College of Engineering |
| Pawan Gawali | Sinhgad College of Engineering |
| Prashant Hingalaje | Sinhgad College of Engineering |
| Prashant Jadhav | Sinhgad College of Engineering |
| Pratik Sakhare | Sinhgad College of Engineering |
| Pratik Sanap | Sinhgad College of Engineering |
| Pratim Shah | Sinhgad College of Engineering |
| Rahul Sabale | Sinhgad College of Engineering |
| Rohit Sonje | Sinhgad College of Engineering |
| Sachin Wakchaure | Sinhgad College of Engineering |
| Sagar Sharma | Sinhgad College of Engineering |
| Sanket Shinde | Sinhgad College of Engineering |
| Santosh Badgujar | Sinhgad College of Engineering |
| Saurabh Dhamne | Sinhgad College of Engineering |
| Saurabh Jadhav | Sinhgad College of Engineering |
| Shahbaj Sayyad | Sinhgad College of Engineering |
| Shashank Pathrudkar | Sinhgad College of Engineering |

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|---|---|
| Shraddhanand Kore | Sinhgad College of Engineering |
| Shubham Pagariya | Sinhgad College of Engineering |
| Snehal Shende | Sinhgad College of Engineering |
| Sourabh Govekar | Sinhgad College of Engineering |
| Suraj Gavade | Sinhgad College of Engineering |
| Suraj Revankar | Sinhgad College of Engineering |
| Vivek Shelke | Sinhgad College of Engineering |
| Yashwant Shetty | Sinhgad College of Engineering |

### 4.3. Venue

Sinhgad College of Engineering
S. No. 44/1, Vadgaon Budruk,
Off. Sinhgad Road,
Pune, Maharashtra 411041

## 3. Workshop Outline

**Table 3. Detailed list and narrative of the sessions conducted during the workshop.**

| Day 1: Timing: 10.00 am to 6.00 pm | | |
|---|---|---|
| **Number** | **Time** | **Title** |
| 1.1 | 10.00 am – 10.20 am | **Warming Up**<br>**Trainer: Vivek Gilani** |
| 1.2 | 10.20 am – 11.00 am | **Group Debate: Position mapping and articulation towards understanding of Climate Change**<br><br>**Moderators: Milkesh Potdar, Nitin Pasricha, Shreya Mundhra**<br><br>Moderators initiate discussions towards student perceptions and understanding of the term Climate Change and if it is really happening? Personal and group viewpoints emphasized to get students involved in the broader concern of climate change. Moderators are to divide students into three groups: Group 1 - that believes Climate Change is happening and the arguments to support their stand; Group 2 - that supports the fact that climate change is a naysayer's dream; and lastly, Group 3 - that feels there needs to be a development for the greater good and impact from climate change is justifiable for the developing nations. |
| 1.3 | 11.00 am – 11.30 am | **Do The Math & The Story of Solutions**<br><br>**Moderator: Nitin Pasricha**<br><br>Are fossil fuels greater than us? can we emit 565 more gigatons of carbon dioxide and stay below 2°C of warming? Exploring the idea on how we can move our economy in a more sustainable and just direction, starting with orienting ourselves toward a new goal. |

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|---|---|---|
| 1.4 | 11.30 am – 11.45 am | **Introduction to Integrative Design – 'Performance by Design': A short video prepared by the Rocky Mountain Institute**<br><br>**Moderator: Nitin Pasricha**<br><br>Trainer showcases a documentary on High Performance by Integrative Design, the first instalment in the High Performance Building Series to provide an in-depth analysis as to the integrative design process. The film includes examples of how design teams collaborate in new ways to integrate high-performance design elements, such as daylighting, energy efficiency and renewable energy, for optimal performance. Trainer initiates charrette discussions and see the design process unfold on projects such as the Empire State Building retrofit, Missouri Department of Natural Resources, Phipps Conservancy, the Desert Living Centre, Willow School and Chicago Botanic Gardens. |
| 1.5 | 11.45 am – 1.00 pm | **Climate Justice and the Built Space: an Introduction to Fairconditioning**<br><br>**Trainer: Vivek Gilani**<br>**Session Jockey: Nitin Pasricha**<br><br>The trainer introduces the Fairconditioning Program, focusing on the Academic Curricula Integration project (ACIP). The trainer additionally elucidates the relationship between the existing problems with our Built Space and Climate Change, further underpinning the guiding principles of the overarching program, and the underlying reasons for devising this specific intervention. The trainer will further highlight upon the realm of curricula integration as viewed by the Program's Executive Board and Board of Advisors. |
| *Break 1* | *1.00 pm – 1.45 pm* | *Fuel Up (Lunch, Walk, Breathe)* |
| 1.6 | 1.45 pm – 2.00 pm | **Workshop Objectives and Participant Expectations**<br><br>**Trainer: Vivek Gilani**<br>**Session Jockey: Nitin Pasricha**<br><br>The trainer presents the overarching workshop structure, content, activities and objectives. The trainer further highlights key takeaways - all in the context of embedding efficiency and sustainability within the existing concepts, so as to bridge the gap between knowledge and action and improve the cooling design skills and software simulation skills. |

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| 1.7 | 2.00 pm – 2.30 pm | **Group Debate: Personal position recalibration in the context of new knowledge about Climate Change**<br><br>**Moderators: Milkesh Potdar, Nitin Pasricha, Shreya Mundhra and Vivek Gilani**<br><br>A follow up from the previous ice-breaker, the trainer aims to initiate a dialogue between students after having shared the facts and figures relating to climate change. The aim of this session to see if there is any change in viewpoint and stance of students on climate change. |
| 1.8 | 2.30 pm – 3.15 pm | **Building Physics 1 - Forms of Heat applicable in Building Physics, heat transfer, Psychrometrics, climate analysis and solar geometry.**<br><br>**Trainer: Vivek Gilani**<br>**Session Jockey: Nitin Pasricha**<br><br>The trainer highlights fundamental concepts of heat transfer in a building, achieving thermal comfort with least amount of energy; controlling convection-radiation-conduction to understand its effect on the building's environment. Trainer further introduces Psychrometry, U and R-values, the analysis of different climates; and shadow masks. The trainer addresses the relationship between buildings and heat, the idea of cooling load and the primary processes that give rise to it, the influence of sensible and latent heat on building design and how the psychrometric chart helps aid the process of building design. The trainer further ensures that cooling load reduction and passive design strategies are given more importance before the different sustainable cooling technologies are explored. |
| *Break 2* | *3.15 pm – 3.30 pm* | *Recess for the mind* |

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|---|---|---|
| 1.8 | 3.30 pm – 4.30 pm | **Building Physics 1 - Forms of Heat applicable in Building Physics, heat transfer, Psychrometrics, climate analysis and solar geometry (cont.)**<br><br>**Trainer: Vivek Gilani**<br>**Session Jockey: Nitin Pasricha**<br><br>The trainer highlights fundamental concepts of heat transfer in a building, achieving thermal comfort with least amount of energy; controlling convection-radiation-conduction to understand its effect on the building's environment. Trainer further introduces Psychrometry, U and R-values, the analysis of different climates; and shadow masks. The trainer addresses the relationship between buildings and heat, the idea of cooling load and the primary processes that give rise to it, the influence of sensible and latent heat on building design and how the psychrometric chart helps aid the process of building design. The trainer further ensures that cooling load reduction and passive design strategies are given more importance before the different sustainable cooling technologies are explored. |
| 2.1 | 4.30 pm – 6.00 pm | **Building Physics 2 - Passive design theory and application**<br>**Trainer: Vivek Gilani**<br>**Session Jockey: Nitin Pasricha**<br>In continuation to day 1, the trainer covers the following topics: Passive Building Design, Fundamentals of Solar Geometry and the different ways of reducing heat ingress through design interventions, thermal heat loads on buildings, greenhouse effect and bioclimatic chart. The trainer further provides an understanding of vernacular and climate adaptive design, importance of using local materials. The trainer helps the students in understanding thermal comfort as the goal while recognizing artificial cooling as merely one of the means to achieve it, adaptive comfort criteria and its energy and environmental conservation benefits. |
| **Day 2:** Timing: 9.30am to 6.00pm | | |

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|---|---|---|
| 2.1 | 9.30 am – 10.30 am | **Building Physics 2 - Passive design theory and application (cont.)**<br>**Trainer: Vivek Gilani**<br>**Session Jockey: Shreya Mundhra**<br>In continuation to day 1, the trainer covers the following topics: Passive Building Design, Fundamentals of Solar Geometry and the different ways of reducing heat ingress through design interventions, thermal heat loads on buildings, greenhouse effect and bioclimatic chart. The trainer further provides an understanding of vernacular and climate adaptive design, importance of using local materials. The trainer helps the students in understanding thermal comfort as the goal while recognizing artificial cooling as merely one of the means to achieve it, adaptive comfort criteria and its energy and environmental conservation benefits. |
| 2.2 | 10.30 am – 11.15 am | **Thermal Comfort and Indoor Air Quality - The basic concepts, measurements and standards of thermal comfort and Indoor Air Quality**<br>**Trainer: Vivek Gilani**<br>**Session Jockey: Shreya Mundhra**<br>The trainer elucidates on the following concepts: Thermal comfort and its influencing factors, Solar passive design, Envelope design and its material property, Mode of heat transfer - conduction, convection and radiation. The trainer additionally highlights: adaptive comfort – one size fit all approach, micro climate and how it is affected by landforms, and street width or other external factors. |
| *Break 1* | *11.15 am - 11:30 am* | *Recess for the Mind* |
| 2.3 | 11.30 am - 12:15 pm | **Active Cooling - Efficient HVAC Systems**<br>**Trainer: Vivek Gilani**<br>**Session Jockey: Shreya Mundhra**<br>The trainer brings about the issue of growing Airconditioning demand with regard to building sector growth. Conventional building EPI and Energy efficient building EPI & its effect on electricity consumption is also discussed by the trainer. The trainer ensures that the students are aware of and understand the environmental, spatial and structural implications of using this technology, in comparison the conventional HVAC systems for building design. Further, working of Refrigeration & AC – basics of enthalpy, Coefficient of Performance to evaluate the whole system, introduction to terms like Integrated Part Load Value, Energy Efficiency Ratio and cooling load estimation format – models used for simulation are also covered by the trainer. |

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| 2.4 | 12.15 pm – 1.00 pm | **Natural Refrigerant Air Conditioning**<br>**Trainer: Vivek Gilani**<br>**Session Jockey: Shreya Mundhra**<br>The trainer ensures that the students are aware of and understand the environmental, spatial and structural implications of using this technology, in comparison the conventional HVAC systems for building design. The trainer further ensures that the students realize that these are already commercially available and implementable technologies, further emphasizing that they are sustainable technologies and not alternative technologies. The trainer also covers the environmental benefits of using this technology as it replaces f-gasses, along with the different safety implications and application constraints.<br>This focuses on Unitary and Centralized systems, with a special module on R-290 based refrigerant technology. The trainer also highlights the need to leapfrog to natural refrigerants, which is possible. The session also delves into the issues with usage of carbon dioxide as a natural refrigerant and lack of commercial application examples. |
| *Break 2* | *1.00 pm – 1.45 pm* | *Fuel Up (Lunch, Walk, Breathe)* |
| 2.5 | 1.45 pm – 2.00 pm | **Question – Answers Discussion** |
| 2.6 | 2.00 pm – 2.45 pm | **Solar Vapour Absorption Machines**<br>**Trainer: Vivek Gilani**<br>**Session Jockey: Shreya Mundhra**<br>The trainer ensures that the students are aware of and understand the environmental, spatial and structural implications of using this technology, in comparison the conventional HVAC systems for building design. The trainer further delves into the fact that these techniques are commercially available and easily implementable, and are ‘sustainable’ and not alternative technologies. The trainer also presents the environmental benefits of this technology since it avoids vapour compression. Along with the aforementioned points, the trainer explains the climatic constraints of evaporative cooling overcoming them by blending with conventional HVAC systems to still derive energy efficiency and low f-gas benefits. |

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| 2.7 | 2:45 pm - 3.15 pm | **Direct/Indirect Evaporative Cooling**<br>**Trainer: Vrajlal Kanetkar**<br>**Session Jockey: Shreya Mundhra**<br>The trainer ensures that the students are aware of and understand the environmental, spatial and structural implications of using this technology, in comparison the conventional HVAC systems for building design. The trainer further delves into the fact that these techniques are commercially available and easily implementable, and are 'sustainable' and not alternative technologies. The trainer also presents the environmental benefits of this technology since it avoids vapor compression. Along with the aforementioned points, the trainer explains the climatic constraints of evaporative cooling overcoming them by blending with conventional HVAC systems to still derive energy efficiency and low f-gas benefits. |
| *Break 3* | *3.15 pm - 3.30 pm* | *Recess for the mind* |
| 2.8 | 3.30 pm – 4.15 pm | **Structure and Radiant Cooling**<br>**Trainer: Shrikant Kaduskar**<br>**Session Jockey: Shreya Mundhra**<br>The trainer ensures that the students are aware of and understand the environmental, spatial and structural implications of using this technology, in comparison the conventional HVAC systems for building design. The trainer also explains the different types of these cooling techniques, along with their application in different circumstances. The trainer further delves into the fact that these techniques are commercially available and easily implementable, and are 'sustainable' and not alternative technologies. The trainer further explains the environmental benefit of structure and radiant cooling as it reduces vapor compression. The trainer also explains how the partial addressing of cooling load is overcome by blending with conventional HVAC systems to derive energy efficiency and low f-gas benefits. |
| 2.9 | 4.15 pm – 5.15 pm | **Life Cycle – Carbon Foot-printing and economics**<br>**Trainer: Vivek Gilani**<br>**Session Jockey: Shreya Mundhra**<br>The trainer explores the economic rationale behind switching to a carbon free lifestyle, the costs associated with each action of ours, and how much CO2 it releases into the atmosphere. Further, the trainer discusses the life cycle costs of various technologies, payback periods and benefits of using alternative technologies. How to calculate these associated costs and justify the use of these. |
| 2.10 | 5.15 pm – 5.30 pm | **Question – Answers and Discussion** |
| **Day 3:** Timing: 10.00am to 6.00pm | | |

| | | |
|---|---|---|
| 3.1 | 10.00 am – 1.00 pm | **Introduction to Energy Modelling: Demonstration of Smart Energy Modelling**<br>**Trainer: Mihir Shah**<br>**Session Jockey: Nitin Pasricha**<br>The trainer introduces to the students a web based tool to calculate HVAC load and further simulate those effects on the building's performance. The trainer explains various capabilities of the Smart Energy software. |
| *Break 1* | *1.00 pm – 2.00 pm* | *Lunch Break* |
| 3.2 | 2.00 pm – 6.00 pm | **Smart Energy Tool - Modelling Sustainable Cooling Technologies**<br>**Trainer: Mihir Shah**<br>**Session Jockey: Nitin Pasricha**<br>The trainer conducts practice sessions with the students on the smart energy tool in a Computer Lab. |
| **Day 4:** Timing: 10.00am to 6.00pm | | |
| 4.1 | 10.00 am – 1.30 pm | **Case study detailing:** *Doing heat load calculations and modelling an output that demonstrates sustainable building design incorporating sustainable cooling technologies and techniques*<br>**Trainer: Mihir Shah**<br>**Session Jockey: Nitin Pasricha**<br>In this session, students will be assigned a problem statement and asked to generate heat loads and run simulations on the Smart Energy tool. The trainer would showcase the capability of the software, advantages and limitations. Further, need for these software's, basic terminologies, importance of internal load and pay back periods will be discussed.<br><br>*Student Assessment on simulation of case study using Smart Energy tool applications.* |
| *Break 1* | *1.30 pm – 2.15 pm* | *Lunch Break* |
| 4.2 | 2.15 pm – 3.15 pm | **Review of Simulation results from student's assessments, Discussions and Q&A Session**<br>**Trainer: Mihir Shah**<br>**Session Jockey: Nitin Pasricha** |

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|---|---|---|
| 4.3 | 3.15 pm – 4.15 pm | **Assessment test conducted by cBalance/ Fairconditioning Team**<br><br>**Moderators: Milkesh Potdar, Nitin Pasricha, Shreya Mundhra** |
| **Day 5:** Timing: 10.00am to 6.00pm | | |
| 5.1 | 10.00 am – 2.00 pm | **Site Visit 1: Suzlon One Earth, Hadapsar, Pune** |

# 4. Workshop Outcome

## 4.1. Overall Learning's for Project Enhancement

The overall learning's for workshop enhancement are stated as follows:

- Formulating a plan to understand the different ways all the knowledge accumulated by the students can be implemented and integrated into their curricula and how the ACIP team can be more involved in this process of integration.
- Emphasizing on the consequences of Climate Change and helping the engineering students understand its importance in order to engrain the importance of sustainable cooling technologies in their syllabus.
- Re-structuring the workshop outline as as to give more time to sustainable cooling technologies, as suggested by students so as to provide a clearer understanding of each of these concepts along with

# 5. Feedback Summary

## 5.1. Written Feedback

Participants were also provided with a feedback form, responses of which have been calculated and summarized below:

- All participants believed that the content of the training matched the objectives of the workshop and they were extremely satisfied with the quality of the workshop. They further believed that this workshop was better than what they expected and that all these concepts were relevant to the workshop.
- Participants responded positively and rated the trainers in higher scales, elaborating on how they helped them understand the difficult concepts in a simple manner, with a common response of 1) trainers using a good level of jargon, 2) presentations being relevant to the topic 3) trainers having a good pace of delivery, providing adequate time for question answer sessions with the students 4) concepts being well taught.
- A majority of the participants responded stating that they would like to spend more time on Building Physics, Sustainable Cooling Technologies and Psychrometry.
- The participants also responded positively, when asked about the Smart Energy software stating that they found it of a lot of use, and will be using it in the future.
- All participants believed that this workshop made them more aware of climate change and inspired them to be more involved in its mitigation.

# 4. Annexure

## 6. Evaluation by cBalance

# THOUGHTFUL COOLING

Cooling Interiors Efficiently and Sustainably

ASSESSMENT TEST

DURATION: 1.5 HOURS | MAXIMUM POINTS: 100

PARTICIPANT DETAILS

Name: _____Branch & Year:_____

Email ID:_____

Signature:_____Date:_____

TEST PAPER CODE: FC-ESC-V2

INSTRUCTIONS

1. This question paper is not here to test your memory skills, speed of answering, or validate your 'cleverness' in scoring high-marks; its designed to help us gauge if we have been able to fortify your understanding of science and engineering principles, spark your curiosity, and foster critical thinking skills amongst you to aid you as you cool India efficiently and sustainably through your professional endeavors
2. Discussion with your colleagues during this test is futile; it will detrimentally affect your learning
3. Use of calculators, text books, reference documents is allowed
4. Unanswered questions will fetch zero points, incorrectly answered questions will fetch negative marks equal to 1/3$^{rd}$ of the full marks carried by that question
5. Points carried by Questions are explicitly stated beside the question
6. Some questions can have more than one correct answer and where applicable will be explicitly stated in the question's framing statement
7. Answers to questions should be marked on separate multiple-choice answer sheets
8. Calculations etc. can be done in your own note-books, other sheets of paper; we plan to reuse these test papers to conserve resources and reduce carbon footprint. Hence we request you refrain from ink or pencil marks on the test paper

9. We have worked assiduously to devise a test will help you become a skilled ‘negawatts’ generator for the world, to become a guardian of climate justice. We urge you to respect this exercise as much as we have respected you in framing these questions

***We hope you will find this test enjoyable and meaningful***

QUESTIONS

1. To limit climate change to 2 $^0$C of temperature rise compared to pre-industrial levels, we must globally reduce carbon emissions by this percentage by 2050 *( 1 point)*

a) 20 %
b) 40%
c) 50 %
d) 75 %

2. As part of COP-15, India's commitment to Climate Change mitigation is? *(1 point)*

a) No commitment
b) committing to the same level of reductions as China
c) 20-25 % reduction of GHG Intensity of GDP by 2020 relative to 2005 levels
d) 565 Gigatons of CO2e

3. Certain substances used in refrigeration industries cause global warming without contributing much to ozone layer depletion. Choose among these, the one(s) that have a significant Global Warming Potential (GWP) but have a negligible Ozone Depletion Potential *(1 point)*

a) Chlorofluorocarbons (CFC)
b) Halons
c) Hydro-chlorofluorocarbons (HCFC)
d) All of these

4. CFCs were replaced with HCFCs to solve the Ozone Depletion issue. As HCFCs were seen to possess a high GWP, we have a choice to leapfrog to natural refrigerants. However, the refrigeration industry seeks to push 'stop gap' solutions such which also have high GWPs. These are *( 1 point)*

a) Hydro-fluorocarbons (HFCs)
b) Carbon Dioxide
c) Hydrocarbons (HCs)
d) All of these

5. Choose among these the low-GWP natural refrigerants that have potential to replace currently used high-GWP refrigerants *(1 point)*

a) Ammonia
b) Carbon Dioxide
c) Hydrocarbons (HCs) eg. Propane (R290)
d) None of these

6. Total Equivalent Warming Impact of ACs are a consequence of? (select all that are true) *(1 point)*

a) Direct emissions of high-GWP refrigerants from AC systems
b) Emissions due to use of fossil-based electricity used by AC equipment
c) Pollutants which affect Indoor Air Quality
d) Absence of fresh air

7. India must 'leapfrog' to sustainable cooling because (select all that apply)? *(2 points)*

a) It has built most of its building space that will exist for many decades
b) Is yet to build 70% of the total built-space that will exist by 2030

c) Is about to witness a rapid doubling of installed ACs every 7 years
d) It will leads to generation of 'negawatts' which can be used for inclusive sustainable development

8. India has a low per-capita carbon footprint because? *(1 point)*

a) We are inherently environmentally friendly, we believe in recycling everything
b) We live simple lifestyles where personal values matter much more than consumption
c) Emissions of wealthy Indian citizens with high carbon footprints are greatly lowered by the near-zero carbon footprint of many less privileged Indians; we 'hide behind our poor'
d) We are a socialist economy

9. Moisture poses a significant challenge for air conditioning systems which must perform 'work' to combat humid conditions as opposed to dry conditions because (select all that apply)? *( 2 points)*

a) Moisture is a form of energy; latent heat energy
b) When moisture condenses it releases its latent heat of evaporation which must be 'pumped out' by the AC
c) Water has a high boiling point
d) Water has high latent heat which when released adds a significant cooling load

10. A wall made with material that possesses good thermal conductivity (i.e. high value of heat conduction, Watts per meter square per meter thickness per degree Kelvin temperature gradient) can be made less conducting (i.e. more resistant to heat flow) by increasing its thickness sufficiently so that it may perform better (resists heat better) than another wall made of a material with low thermal conductivity? *( 2 points)*

a) True b) False

11. Air-cavity walls and hollow concrete blocks are good insulators and resist heat better than conventional brick walls because? *(2 points)*

a) air has low thermal conductivity b) air promotes convection currents
c) air has low thermal mass d) all of the above

12. Arrange the walls type in order of DECREASING U-values; assume constant wall thickness: Wall A: aerated concrete wall, Wall B: plain concrete wall, Wall C: aerated concrete wall with insulation *(4 points)*

a) Wall A > Wall B > Wall C b) Wall B > Wall A > Wall C
c) Wall C > Wall A > Wall B d) Wall B > Wall C > Wall A

13. Air is a good insulator but has poor thermal mass *(1 point)*

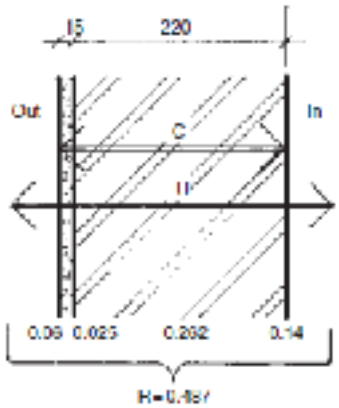
a) True b) False

14. Insulation and thermal mass both mitigate the transfer of heat; but achieve it through different mechanisms; which of the following are true (select all that apply) *(2 points)*

a) Thermal mass delays heat transfer b) Insulation delays heat transfer
b) Thermal mass is independent of density c) Insulation capability is proportional to specific heat capacity

15. Using the given Resistance values (R-values) of components of a wall assembly as shown in the following figure, calculate and state the overall U-value of the wall section from exterior to interior. The wall is 220mm thick and the external plaster is 15mm thick.

*(4 points)*




a) 2.054 W/m$^2$K b) 3.054 W/m$^2$K
c) 67.626 W/m$^2$K d) None of these

16. Thermal mass is a passive design technique that works in which of the following climatic conditions? *(2 points)*

a) High diurnal variation of temperature b) Low diurnal temperature variation
c) Warm and Humid Climate Zone d) Cold Climate

17. Large difference between Dry Bulb and Wet Bulb Temperature indicates? *(1 point)*

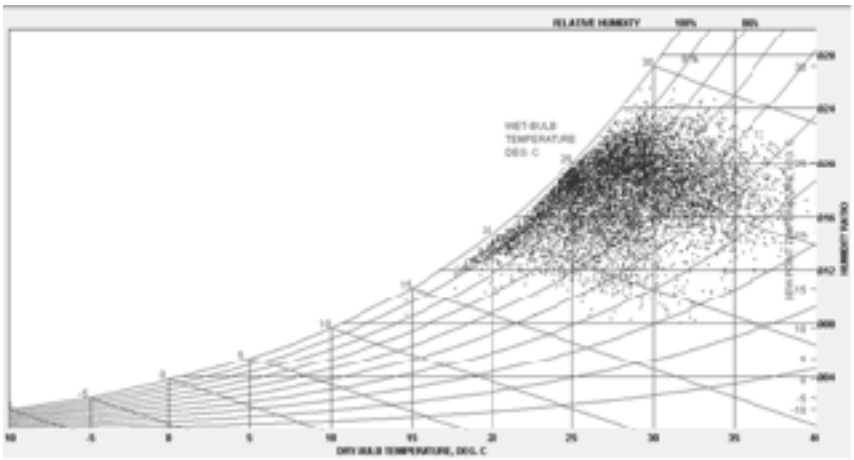
a) The air is humid b) The air is dry
b) Large heat content in air c) High humidity ratio

18. Dry bulb temperature is a measure of? *(2 points)*

a) total enthalpy b) sensible heat
b) saturation c) latent heat

19. Which climate zone does this Psychrometric/Weather Data Chart indicate *(1 point)*

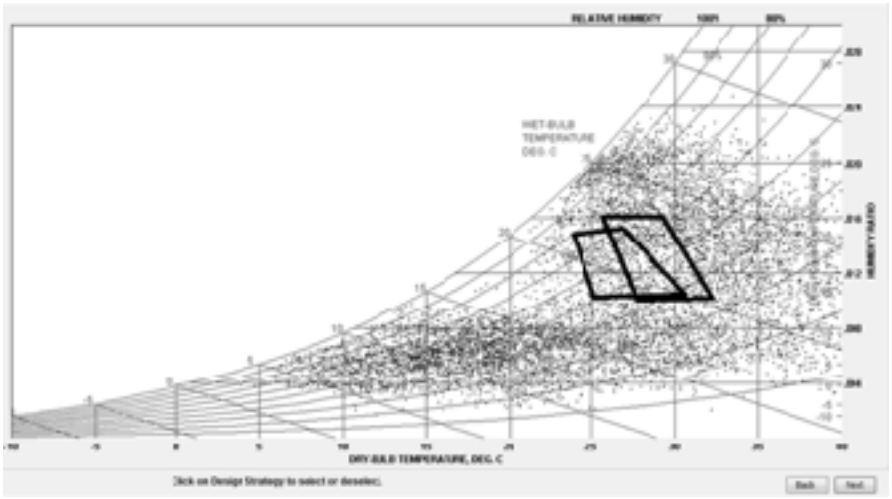
a) Hot and Dry b) Warm and Humid
c) Composite d) Temperate



20. Beyond certain thickness, the thermal resistance offered by an air gap does not increase and begins to drop off *( 2 points)*

a) True b) False

21. The following statements are TRUE about the psychrometric/weather data chart presented below (select all that apply) *(2 points)*




a) Depicts Winter and Summer Comfort Zones
b) Is based on the Adaptive Comfort Model
c) Has only a small percentage of hours in the year where thermal comfort will need to be achieved through improved passive design and/or active cooling
d) Use of an evaporative cooling system is a feasible strategy to improve % of comfort hours

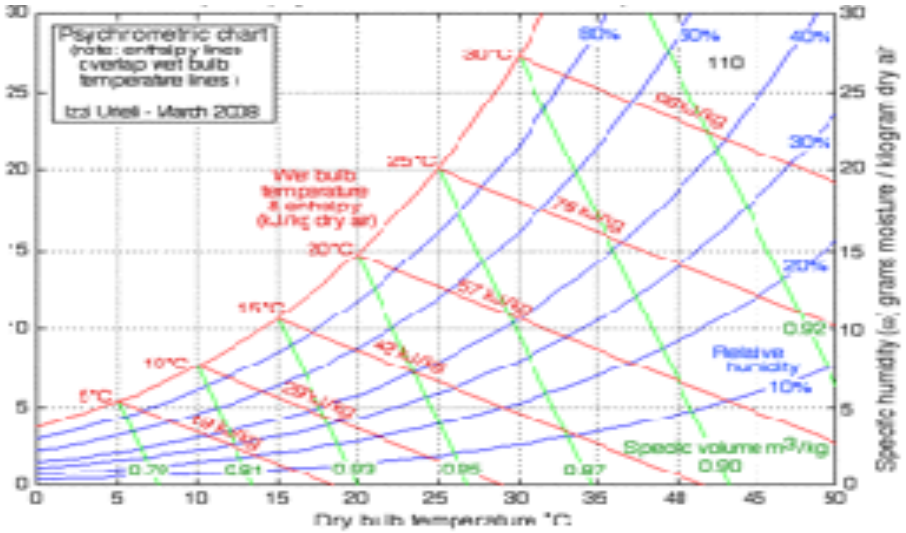
22. If air is cooled beyond its dewpoint temperature, the following phenomenon will occur

*(2 points)*

a) its wet-bulb temperature will increase b) condensation will occur and air will dehumidify
c) evaporation will occur d) the capacity to absorb moisture will increase

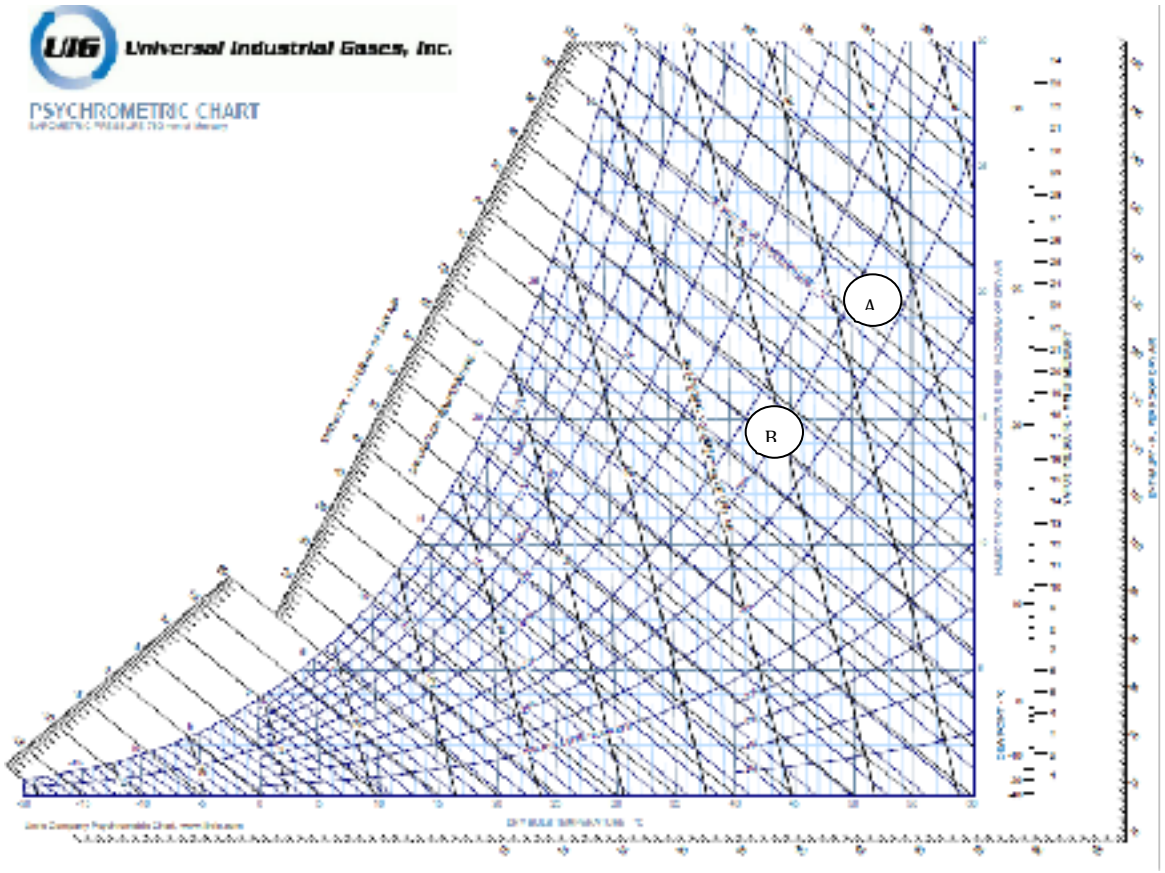
23. Use the following psychrometric chart to determine which of the following are True for the given 'Air' conditions: A has DBT = 20 $^0$C, WBT = 15 $^0$C. B has DBT = 40 $^0$C, WBT = 25 $^0$C *(4 points)*

a) B has higher relative humidity and higher absolute or specific humidity
b) A has lower relative humidity but higher absolute humidity or specific humidity
d) B has lower relative humidity but higher absolute humidity or specific humidity
e) A has higher relative humidity and higher absolute humidity or specific humidity




24. Use the following psychrometric chart to determine which 'Air' condition, A or B, contains more energy and which one will lead to higher AC consumption *(4 points)*

a) A contains more energy and hence AC will consume more energy
b) B contains more energy and hence AC will consume less energy
c) A contains less energy and hence AC will consume less energy
d) B contains less energy and hence AC will consume more energy




25. The thermal property of building materials / coatings (plasters etc.) that is desirable to facilitate night-sky radiation to cool walls and roofs passively is ? *(2 points)*

a) high absorbtance
b) high transmittance
c) low emissivity
d) high emissivity

26. Declination (i.e. tilt) of the earth's axis relative to the orbital plane causes all of the following, which leads to seasons, except? *(2 points)*

a) varying in daylight hours
b) varying angle of incident solar radiation
c) varying distance travelled by solar radiation through the atmosphere
d) varying distance from the sun

27. Altitude of the sun at 2 pm of a given day depends primarily on? *(2 points)*

a) Latitude only
b) Latitude and Longitude
c) Longitude and month of the year
d) Latitude and day/month of the year

28. Which of the following is a FALSE statement about the altitude of the sun? *(2 points)*

a) Higher during summer
b) Varies with time of the day

c) Is lowest during morning and evening hours d) Does not affect design of shading devices

29. Horizontal overhangs as shading devices are best suited for which direction? *(2 points)*

a) North b) South
c) East d) West

30. Rank the following in order of priority for sustainable building design: A - sustainable cooling technologies, B - reducing thermal loads, C - renewable energy, D – passive cooling technologies? *(2 points)*

a) D, C, B, A b) B, D, A, C
c) A, B, C, D d) B, C, D, A

31. Which rating system is proposed to be 'mandatory' requirements to be followed by large commercial buildings in India in the next few years *(1 point)*

a) GRIHA Ratings b) IGBC Ratings
c) LEED Ratings d) ECBC

32. The Bureau of Energy Efficiency (BEE) has instituted a Star Rating Program that is based on which benchmarking parameter *(2 points)*

a) kWh per month b) kWh/$m^2$/year
c) solar energy per $m^2$/year d) Electricity cost (INR)/$m^2$/year

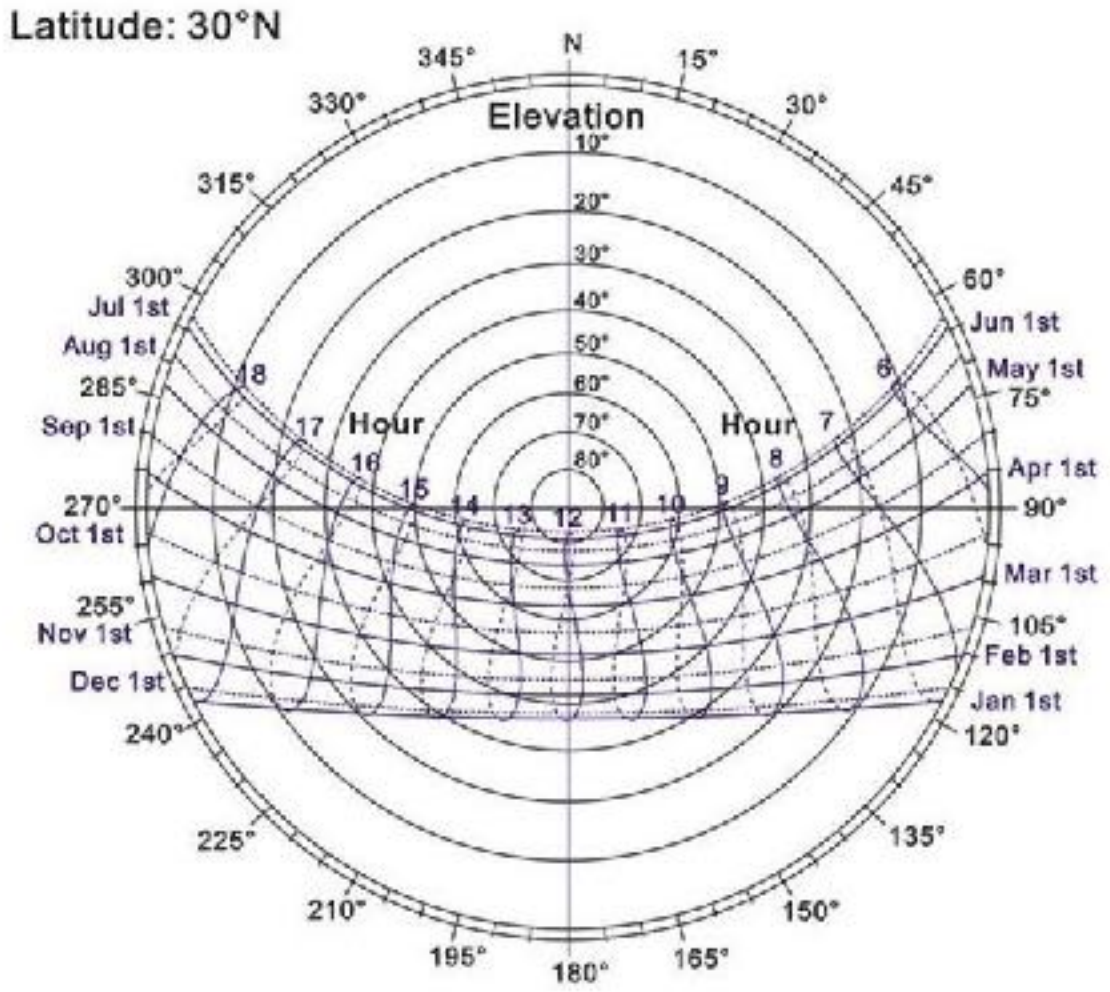
33. Which among the following air properties affect thermal comfort of building occupants?

*(1 point)*

a) Temperature b) Humidity
c) Air Speed d) All of these

34. Use the sun-path diagram below to determine the date/time on which the larger (more protruding) horizontal shading device will be required *(4 points)*

a) 1 pm on May 1 b) 4 pm on September 1




35. Humans can tolerate higher indoor temperatures in summer and lower temperatures in winter? *(2 points)*

a) True b) False

36. Which of the following is a FALSE statement about Thermal Comfort? *(2 points)*

a) Standards for defining its range have historically been rigid but now recognize human adaptation to thermal conditions
b) Is a subjective phenomenon and compliance with these is estimated using modelling or measured through occupant surveys
c) Different criteria can be used for defining its range for different zones in a building
d) Cannot be met by Passive Design / Cooling approaches; necessitates use of conventional Air Conditioning

37. Conventional HVAC systems pose 2 major issues; use of air for cooling and electric compressors. The following are valid reasons, except one that is FALSE *(2 points)*

a) air has low thermal conductivity and thermal mass
b) compressors add ‘energy’ to then pump it out through a condensor

c) is not a spontaneous process ; does not allow a building to ‘drain’ its heat
d) a small amount of air is required to achieve the same cooling as a large quantity of water

38. Flammability concerns related to use of R290 (Propane) can be addressed most effectively through which of the following safeguards? *(2 point)*

a) Installing fire-extinguishers in rooms
b) Limiting the amount of refrigerant charge in the AC so that the lower explosive limit is not breached during an accident which causes the refrigerant to leak
c) Ensuring no smoking in the premises where these ACs are used
d) Using HFCs instead which have high GWPs but don’t post any risk at all

39. Natural refrigerants can be used in split AC systems, but not in central AC systems

a) True b) False *(1 point)*

40. Hydrocarbons (HCs) are one of the most promising low-GWP replacement options for the currently used high-GWP and Ozone Depleting refrigerants. However, the HCs are currently being discarded by the refrigerant industry due to its high flammability. Other systems that are greatly used in habitable spaces in-spite of having substances with high flammability or with similar risks of explosion, are (select all that apply) *(2 points)*

a) Cooking gas cylinders in household kitchen b) CNG cylinders in vehicles
c) Pressurised pressure-cooker in household kitchen d) None of these

41. Solar VAM Systems employ all of the following processes except? *(2 points)*

a) evaporation of water under low pressure to create cooling in the evaporator
b) absorption of refrigerant into a hygroscopic substance to release latent heat
c) a regenerator + absorber that replaces the compressor of a conventional AC system
d) expansion valves to cool the refrigerant sufficiently to enable it to absorb room heat

42. Solar VAM Systems exhibit COPs (~ 0.6) much lower than VCR systems (~ 3.0 to 4.0). Yet, they can be environmentally beneficial for all the following reasons except one FALSE reason *(2 points)*

a) they use a natural refrigerant (water)
b) they eliminate the electricity required for a operating a compressor
c) they can be operated largely on inexpensive renewable energy sources (waste heat, solar heat)
d) they replace air cooling with cooling of absorbents with high thermal mass

43. Radiant/structure cooling systems address which part of the cooling load in a building? *(2 points)*

a) Latent Heat b) Sensible Heat
c) None of these d) All of these

44. A Radiant cooling system seeks to maintain an Operative Temperature of 22 $^0$C. If it uses a chiller and radiant pipe network system that produces a Mean Radiant Temperature of 19 $^0$C, what Air Temperature can it set for the air conditioning system to maintain comfort conditions? *( 2 points)*

a) 22 $^0$C
b) 25 $^0$C
c) 20 $^0$C
d) 28 $^0$C

45. A structure cooling system employs all of the following processes except? (select all that apply) *(2 points)*

a) use of massive walls to delay heat transfer
b) use of water flow to provide thermal mass
c) a chiller to cool water
d) a heat pipe and radiator + fan to reject heat from return water without use of excessive electricity

46. The most effective strategy to mitigate the potential for condensation occurring on radiant cooled surfaces is? *(2 points)*

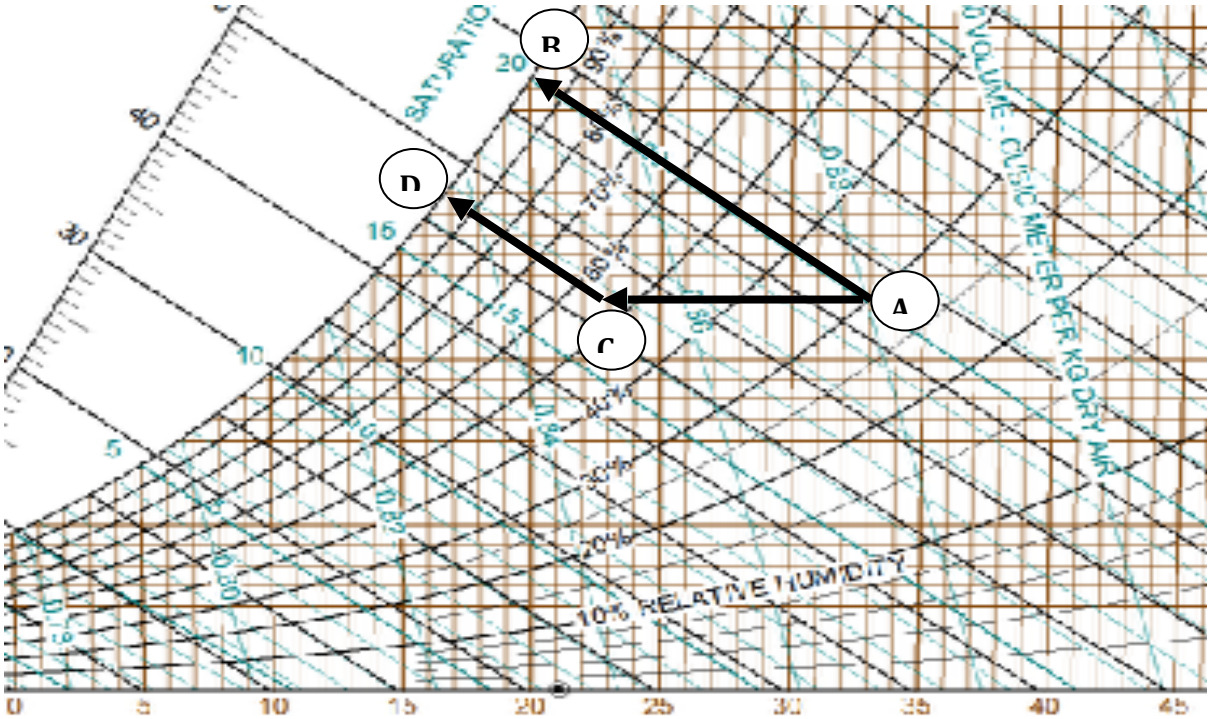
a) reduce humidity generation / ingress into the cooled space
b) simultaneously operate a evaporative cooler
c) ensure that the supply water temperature is well above dew point temperature for the desired dry bulb and relative humidity conditions
d) use water proof PEX pipes for circulating chilled water

47. A building employs 3 different configurations of radiant cooling systems using the same pipe network and chiller specifications (i.e. the only difference is their spatial placement). Their cooling outputs are as follows: A – 70 W/sq.m, B – 50 W/sq. m, C – 35 W/sq. m. It is most likely that System A is *(2 points)*

a) wall cooling system
b) floor cooling system
c) slab cooling system
d) ceiling cooling system

48. The psychrometric chart below depicts the cooling achieved by 2 sustainable cooling systems, one is an evaporative cooling (EAC) system, and the other a combined indirect-direct evaporative cooling (IDEC) system. Pathways A-C-D and A-B depict these 2 system's psychrometric processes. The final dry bulb temperatures achieved by the systems are? *(4 points)*

a) EAC: 20 $^0$C, IDEC: 20 $^0$C
b) EAC: 20 $^0$C, IDEC: 17 $^0$C
c) EAC: 20 $^0$C, IDEC: 22 $^0$C
d) EAC: 33 $^0$C, IDEC: 17 $^0$C




49. An indirect-direct evaporative cooling system provides 10,000 $m^3$/hr of air flow. The enthalpy of ambient air (before cooling) is 60 kJ/kg and the enthalpy of cooled air is 40 kJ/kg. What is the approx. cooling achieved by the system? *(4 points)*

*Constants: Air Density at ambient temperature is 1.12 kg/m3, 1 TR = 3.517 kW, 1 kW = 1 kJ/second*

a) 18 TR
b) 12 TR
c) 14 TR
d) 10 TR

50. In mildly humid regions where air conditioning is required, the COP and size of HVAC systems (TR) can be significantly reduced by employing a IDEC system to pre-cool ambient air used for the fresh air intake

a) True
b) False *(1 point)*

## 2. Feedback Form

**Thoughtful Cooling - Engineering Student Certificate Workshop**

**Fairconditioning Feedback Form**

Dear student, we thank you for participating in the workshop and hope that you enjoyed it as much as we did. Your feedback will help us to ensure that we continue to meet your training needs and improve our future workshops.

**Personal Details**

**1. Full Name (Optional)**

**2. Email**

**3. College**

**4. What is your course?**

Please choose **only one** of the following:

- ○ First Year B.Tech
- ○ Second Year B.Tech
- ○ Third Year B.Tech
- ○ First Year Masters
- ○ Second Year Masters
- ○ PhD.

**5. The program made you want to learn more on efficient cooling**

Please choose **only one** of the following:

- ○ Strongly Agree
- ○ Agree
- ○ Neither Agree nor Disagree
- ○ Disagree

○ Strongly Disagree

**6. Content of the training matched the objectives of the workshop?**

Please choose **only one** of the following:

○ Strongly agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly Disagree

**7. How well did the workshop meet your expectations? Was it...?**

Please choose **only one** of the following:

○ A lot better than expected

○ Better than expected

○ Med my expectations

○ Worse than expected

○ A lot worse than expected

**8. Score the trainer / session / presentation based on the following criteria.** ***(ALL ANSWERS HAVE A DIFFERENT ANSWER SCALE, READ THEM CAREFULLY)***

| | Use of Jargon (10 is excessive and 1 is negligible) | Relevance of presentation (10 is extremely relevant and 1 is highly irrelevant) | Pace of delivery (10 is extremely fast and 1 is too slow) | Concepts were explained clearly (10 is Strongly Agree & 1 is Strongly Disagree) |
|---|---|---|---|---|
| 1.2. Group Debate: Personal position mapping and articulation in the context of Climate Change | | | | |
| 1.3. Do the math & the story of solutions | | | | |
| 1.4. Integrative Design | | | | |

| | Use of Jargon (10 is excessive and 1 is negligible) | Relevance of presentation (10 is extremely relevant and 1 is highly irrelevant) | Pace of delivery (10 is extremely fast and 1 is too slow) | Concepts were explained clearly (10 is Strongly Agree & 1 is Strongly Disagree) |
|---|---|---|---|---|
| 1.5. Climate Justice and the Built Space: an Introduction to Fairconditioning | | | | |
| 1.6. Workshop Objectives and Participant Expectations | | | | |
| 1.7. Group Debate: Personal position recalibration in the context of new knowledge about Climate Change | | | | |
| 1.8. Building Physics 1 | | | | |
| 2.1. Building Physics 2 | | | | |
| 2.2. Thermal Comfort and Indoor Air Quality | | | | |
| 2.3. Active Cooling - Efficient HVAC Systems | | | | |
| 2.4. Natural Refrigerant Air Conditioning | | | | |
| 2.6. Solar Vapour Absorption Machines | | | | |
| 2.7. Direct/Indirect Evaporative Cooling | | | | |
| 2.8. Structure & Radiant Cooling | | | | |
| 2.9. Life-Cycle Carbon Footprinting and Economics | | | | |
| 3.1. Site Visits | | | | |
| 4.1. Introduction to Energy Modelling | | | | |
| 4.2. Smart Energy Tool - Modelling Sustainable Cooling Technologies | | | | |

| | Use of Jargon (10 is excessive and 1 is negligible) | Relevance of presentation (10 is extremely relevant and 1 is highly irrelevant) | Pace of delivery (10 is extremely fast and 1 is too slow) | Concepts were explained clearly (10 is Strongly Agree & 1 is Strongly Disagree) |
|---|---|---|---|---|
| 5.1. Case Study Detailing | | | | |
| 5.2. Review of Simulation Assessments, Q&A Session | | | | |

**9. What topics/concepts would you have liked to spend more time on?**

**10. Did you find any presentation(s) outstanding?**

**11. What are your comments on the overall workshop duration, session(s) duration, structure, etc.?**

**12. Did this program make you more aware about Climate Change?**

**13. Do you think you would be more involved towards mitigation of Climate Change?**

**14. What are your thoughts on the Smart Energy software?**

Thank you for taking the time to write your honest responses to the questions in this feedback form.

The Fairconditioning team Like and visit us at:
www.facebook.com/fairconditioning
www.fairconditioning.org