TEE-818 **Advanced Heating, Ventilation and Air Conditioning Systems (HVAC) - 3 CHs**

Background

1. Major portion of energy is consumed by HVAC systems in Pakistan especially during the summer season.
2. An efficient HVAC system can decrease the energy consumption by 35 to 40 percent and heating, ventilation, and air conditioning (HVAC) equipment consumes a substantial portion of energy in commercial buildings—around 40 percent of total building energy consumption depending on climate and other factors
3. It is the need of time to make a solid foundation of human resource in the field of HVAC equipped with theoretical and technical skills to advance its future use and potential in Pakistan. Therefore the current course will fulfill this requirement.
4. The course has been discussed with relative faculty members followed by a detailed discussion in DBS.
5. The course was forwarded to the partner USA universities, Oregon State University and Arizona State University and the received comments are attached.

Rationale

6. Rationale for offering/launching the new course.
    a. An efficient HVAC system can decrease power consumption by 35 to 40 percent and heating, ventilation, and air conditioning (HVAC) equipment consumes a substantial portion of energy in commercial buildings—around 40 percent of total building energy consumption depending on climate and other factors.
    b. Currently very few universities in Pakistan are offering the course on Advanced HVAC systems and country is severely lacking the engineers having specialization in HVAC systems.
    c. Also very few people are there in Pakistan who can perform the modelling, simulation and optimization of the air conditioning systems using modern computer tools that will be covered in this course.
    d. The course will also discuss the HVAC systems running on renewable energy resources rather using the conventional electricity.

Educational Objectives

7. Objectives of the program under which the proposed course will be conducted overall the broad objective of this course is to introduce the energy graduates with the Advanced and modern HVAC systems along with passive and low energy heating and cooling techniques. Graduates will be able to display advanced understanding of relevant scientific theories, ideas, methodologies and the newest technologies in the field of HVAC systems.

Specifically the course is designed to achieve the following objectives

a. Understanding the fundamentals of heating, ventilation, and air conditioning and become familiar with the codes and standards from ASHRAE handbooks

b. Designing, sizing and the modeling of HVAC systems especially estimating the performance, economics and environmental effects of these systems using application software like EES, TRNSYS etc.

c. Understand and implement the efficiency improvement options of compressor based HVAC equipments.

d. Understanding to relate HVAC to other disciplines such as heat transfer, fluids, thermodynamics, control and economics.

e. Become familiar to the HVAC options which are not compressor based and understand the environmental issues of the current HVAC techniques.

Input Obtained from Industry/Corporate Sector/Subject Specialists/Academia

8. The comments received through email from partner USA universities, Oregon State University and Arizona State University is as under:-

a. Thank you for your note and it is nice to hear from you. I hope you are all doing well at NUST. I have reviewed the course outline and I think it is very comprehensive. We have a similar thermal design course that I will be offering this winter, however it does not exclusively focus on HVAC&R. One thing that I believe will make the course even more useful for the students is if they are asked to complete a design/simulation project of an HVAC system. This can be done using the TRNSYS software as you indicate, or also at steady state using the Engineering Equation Solver (EES) software from the same company

(F-Chart). It is available at very reasonable prices and is well suited for modeling and design of thermal systems.

b. I hope to engage some of your students in thermal system design projects if they visit OSU, and I am very interested to see how this course turns out for you.

International Practice

9. Specify the universities of repute where the proposed course is being conducted.

a. NED University Karachi-Pakistan
http://www.neduet.edu.pk/mech/programme.htm#b200

b. UET Lahore Pakistan
http:www.uet.edu.pk/faculties/facultiesinfo/department?RIDgraduateprogram&id17#

c. Oregon State University
http://mime.oregonstate.edu/academics/grad/me/tfs

Proposed Timeframe of Commencement

10. Specifying semester with year. Course will be offered under the stream of thermal energy engineering during spring semester

Course Contents

11. Give details of the course, on the following lines:

a. Course Code

b. Title Advanced Heating, Ventilation and Air conditioning Systems

c. Credit Hours 3

d. Objectives Explained under heading 3

e. **Outcomes**. This course will provide the understanding of cooling system characteristics, dehumidification systems and ventilation control strategies that can be an important part of conserving energy, maintaining comfort, and controlling humidity in buildings. Students will also learn the passive ways of heating and cooling of buildings which may be the alternate of the compressor technology

f. Contents with suggested contact hours

No	Topics	Text Book	Contact Hours
(1)	**Psychrometry** - Evolution of air properties and psychrometric chart - Basic processes such as sensible heating/cooling, humidification/dehumidification and their combinations, steam and adiabatic humidification, adiabatic mixing, etc. - Bypass factor and Sensible heat ratio **Human Comfort and Indoor Air quality** - Heat transfer from body, convection, radiation, conduction, evaporation, clothing resistance, activity level - Concept of human comfort - Thermal response - comfort factors - Environmental indices - Indoor air quality. **Heat Transfer in buildings** - Heat transfer in wall and roof, sol-air temperature, insulation, cooling load temperature difference - Fenestration, types of glass, sun shade, shading coefficient, maximum radiation, cooling load factor.	SW, GH	06
(2)	**Cooling and heating Load Estimation** - Design conditions, outdoor, indoor - External load, wall, roof, glass - Internal load, occupancy, lighting, equipments - Ventilation, air quantity, loads - Load estimation methods. Vapour transfer in wall, vapour barrier, load estimation basics.	SW, GH	04

	Dynamic vs. Static Load Calculations.		
(3)	**Air Distribution** - Ducts, types, fittings, air flow, friction chart, methods of sizing, balancing.	SW, GH	04
(4)	**Ventilation and Ventilation Techniques** - Need, threshold limits of contaminants, estimation of ventilation rates, decay equation, air flow round buildings. Natural, wind effect, stack effect, combined effect - Mechanical, forced, exhaust, combined - Displacement ventilation. Ventilation System Design - Exhaust ducts, filters, blowers, hoods, chimney, etc. **Air-Conditioning Methods**: Air Handling Units, Fan Coil Units, Underfloor Systems, Static Cooling Devices, Packaged Units And Split Systems, VRF Systems Control Systems: Detectors And Sensors, Controllers, Controls Communications, and Planning. Thermal energy storage for Air conditioning application.	SW, GH	12
(5)	**Compressors and their types for refrigeration system. Condensers and Cooling towers and Evaporators.**		06
(6)	**Commercial Refrigeration systems** Detailed discussion of systems used for commercial food preservation and storage, complex installations for supermarkets, and large commercial		06

	ice machines. Includes troubleshooting practices for common commercial refrigeration installations.		
(7)	**Passive and low energy heating and cooling Techniques** **Solar Cooling and heating system** • Solar absorption system; solar adsorption system; solar heating systems; solar desiccant cooling and solar evaporative cooling systems. • Evaporative cooling Techniques • Geothermal heating and cooling systems **Simulation of cooling system using TRNSYS etc (Term Projects)** **Environmental issues related to the HVAC systems**	KP, SM and JC	07

g. Details of lab work, workshops practice (if applicable). NA

h. Recommended Reading (including Textbooks and Reference books).

S. No.	Title	Author(s)	Assigned Code	Remarks
1.	Refrigeration and Air Conditioning	Wilbert F. Stoecker	SW	Text
2.	Building Heat Transfer	Morris Grenfell Davies	GM	Text
3.	Refrigeration and Air-Conditioning	G H Hundy (Author), A. R. Trott (Author), T C Welch	GH	Reference
4.	Solar Cooling	Paul	KP	Referenc

		Kohlenbach, Uli Jakob		e
5	Advances in Passive Cooling	Mat Santamouris	SM	Referenc e
6	Passive Cooling	Jeffrey Cook	JC	Referenc e