	National University of Sciences and Technology
	ARCH - 532 Advance Environmental Controls - HVAC
Course Objectives:	After taking this course the student is expected to have acquired the knowledge of mechanical HVAC services required to condition a building, their function and requirements, and what influence these mechanical systems can have on architectural design of a building. The architectural student will be able to negotiate with a mechanical engineer for the selection of mechanical HVAC system been proposed for the designed building.
Outcomes:	At the completion of the course, students will be expected to have knowledge of: a. Energy concepts of building services; b. Various Mechanical Heating and Cooling Systems in buildings; c. Environmental design requirements for HVAC systems; and d. Mechanical equipment involved, their function and basic layout techniques/components involved in conditioning the indoor environment of a building
Reference Books:	a. Mechanical and Electrical Equipment in Buildings *(Eleventh Edition)* b. Environmental Control Systems, *Fuller Moore* c. Sustainable Building Services, Bernard Lenz, Thomas Stark d. Heating, Cooling, Lighting, Norbert Lechner

Course Contents **Weekly Plan:**	Week 1	**Lecture 1:** a. THERMAL ENVIRONMENTAL CRITERIA (1) Thermal Comfort (2) Factors affecting Thermal Comfort (3) Scope of modern HVAC (4) Introduction to Air Conditioning processes (5) Defining Air Conditioning (6) Basic concepts and terminologies
	Week 2	**Lecture 2:** a. ENERGY CONCEPT OF BUILDING SERVICES (1) Boundary conditions for energy concepts (2) 10 steps to an energy efficient building design (3) Need for Mechanical Equipment (4) Typical design Processes for HVAC **Assignment:** Students are to highlight and explain with reasons which of the 10 steps for an energy efficient building design need to be followed in Architectural Practice in Pakistan.
	Week 3	**Lecture 3:** a. HEATING AND COOLING SYSTEMS IN BUILDINGS (1) Introduction (2) Thermal zones b. HEATING ONLY SYSTEMS IN BUILDINGS c. COOLING ONLY SYSTEMS IN BUILDINGS

		Assignment: Students to select a heating system and evaluate it with pros and cons for its feasibility in Pakistan's climate.
	Week 4	**Lecture 4:** a. AIR-CONDITIONING SYSTEMS IN BUILDINGS (HEATING/COOLING SYSTEMS) (1) All Air Systems (2) Air and Water Systems (3) All Water Systems (4) VRF (Variable Refrigerant Flow) Systems **Assignment:** Students are to propose one of the studied systems for a building (plan and section given) and elaborate with drawing the system's components on the plan.
	Week 5	**Lecture 5:** a. SCHEMATIC ENVIRONMENTAL DESIGN REQUIREMENTS (1) Occupant Density (2) Comfort Factors (3) Rules of thumb for Conditioning Loads (4) Rules of thumb for Cooling Loads (5) Rules of thumb for Electric Loads (6) Rules of thumb for Air Velocity by Building Type (7) Rules of thumb for Environmental Factors (8) Environmental Factors for Ambient Air Temperature **Quiz No. 1**

	Week 6	**Lecture 6:** b. PLANT ROOMS AND SERVICE AREAS (1) Floor space allowance for services (2) Space allowance for Plant Rooms (3) Boiler room space requirements (4) Chiller room space requirements (5) Pumps (6) Anthropometric data for services operation (7) AHU (8) Fans (9) Space allocation for Ducts and Shafts **Assignment:** Students will require bringing a 'space occupancy' study of a real mechanical HVAC plant with dimensions and images from a building in Islamabad.
	Week 7	**PRESENTATIONS BY THE STUDENTS OF THE ASSIGNEMNT GIVEN IN LECTURE 6.**
	Week 8	**Lecture 7:** c. PSYCHROMETRY (1) Typical Air Conditioning processes (2) Heating (3) Moist air sensible heating or cooling (4) Moist air cooling and dehumidification (5) Adiabatic mixing of 2 moist air streams **Numerical problems in class.**
	Week 9	Mid-Term
		Lecture 8:

	Week 10	d. FANS AND DUCTS IN HVAC (1) Fan types for HVAC (2) Fan sizing (3) Duct sizing (4) Pressure losses in ducts (5) Duct design **Quiz no. 2.**
	Week 11	Guest lecture / Site visit
	Week 12	**Lecture 9:** e. SPACE AIR DIFFUSION (1) Mixed systems (2) Factors influencing selection (3) Outlet types (4) Air diffusers (5) Displacement ventilation (6) Under floor air diffusers **Exercise:** Diffuser system design exercise.
	Week 13	**Lecture 10:** f. HVAC CALCULATIONS *(class exercise to design an HVAC system for a two storey building)* **Quiz no. 3.**
	Week 14	SEMESTER PROJECT *(In groups students will bring a case study analysis of a multistory building for HVAC system including detail drawings of system, images of real installment, relationship with architecture/structure and market applicability)*
	Week 15	SEMESTER PROJECT *(ditto)*
	Week 16	SEMESTER PROJECT *(Pin-up of sheets representing the project details and*

	presentation by the students in groups)
Week 17	Revision session
Week 18	**Final Exam**