

## **A COMPARISON OF CIVIL ENGINEERING CURRICULUM AT THE UNIVERSITY OF FLORIDA AND THE NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY, PAKISTAN**

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### **Abstract**

This paper compares Civil Engineering Education curriculum at the University of Florida (UF) with the National University of Science and Technology (NUST), Pakistan. A review of courses from each school is presented to understand the Civil Engineering curriculum structure at two institutions. Each school aims at disseminating the most effective engineering education, by coordinating technological/scientific areas of national, economical and social interests of the country. Civil Engineering education at UF primarily focuses on technical excellence, communication skills, and a well-rounded general and interdisciplinary education. In comparison, NUST focuses on balanced distribution of theoretical knowledge, practical and fieldwork to address real life civil engineering projects. The major curriculum of each school differs based on their socio-economical characteristics, national and industrial needs, and the availability of natural resources. Although the overall curriculum structure may appear different but the basic underlying objective of academic syllabus is the same. This common objective is basically the result of increasing global nature of Civil Engineering education. Undoubtedly, the future of Civil Engineering education strives on the balance of ideas from global perspectives. Thus concluding the paper, it aims at promoting, stimulating and broadening the dialogue among the engineering students, engineering faculty and university administration to develop additional curricular mechanisms through which the two universities can produce the next generation of Civil Engineering graduates.

## **National University of Science and Technology (NUST)**

### **Introduction**

According to a recently published study on engineering education in Pakistan, although new universities with diverse disciplines were established during the last 50 years, these have received inadequate support. Only 0.22 percent of GNP is spent on university education in Pakistan. The profile of engineering education in Pakistan also depicted a dismal picture in 1980s and early 90s<sup>[1]</sup>. Realizing the unsatisfactory state of technological and scientific education in the country, Government of Pakistan set up the National University of Science and Technology (NUST) in March 1993. It was established by pooling together the resources of the army and the civil. NUST is thus a unique venture for the promotion of qualitative education in the country.

NUST is one of the new generations of universities in Pakistan with a progressive and innovative outlook. It is growing as a modern center of excellence for research and development in the field of engineering and technology. The essence underlying the foundation of NUST is based on a unique spectral combination of engineering, management skills, academic quality and spirit of excellence epitomizing its cherished objectives. It is based on a decentralized multi-campus concept, which envisages its constituent colleges to grow and develop as centers of excellence in their own field of specialization.

### **Department of Civil Engineering**

Three component colleges of NUST over which the Department of Civil Engineering is spread are,

- 1) Military College of Engineering (MCE), Risalpur,
- 2) National Institute of Transportation (NIT), Risalpur, and
- 3) Institute of Environmental Science and Engineering (IESE), Rawalpindi

### **Undergraduate Studies**

Military College of Engineering (MCE) is a premier ISO 9000-2000 certified institution of civil engineering in Pakistan, which offers degree courses at the undergraduate level. Civil engineering degree is based on balanced distribution of theoretical knowledge, practical training and fieldwork; terminating into group projects designed to solve practical civil engineering problems. Civil Engineering curriculum offered is University Grants Commission (UGC) and Pakistan Engineering Council (PEC) approved. The syllabi includes subjects of basic sciences and humanities, engineering mechanics, strength of materials, theory of structures, hydraulics, soil mechanics, highway engineering, airport engineering, survey, concrete technology, architecture, computer science etc, (Table 1).

### **Graduate Studies**

National Institute of Transportation (NIT) is a modern and progressive civil engineering institute of the country. It is the first of its kind that offers postgraduate studies in the fields of

transportation, geo-technical and structural engineering. The computer facilities and testing laboratories are equipped with the latest devices or data acquisition systems, and are regularly upgraded to meet the academic and research needs.

**Table 1** BACHELORS OF CIVIL ENGINEERING (BE), MCE, RISALPUR

Course	Course Title	Credits	Course	Course Title	Credits
BS-101	Mathematics-I	4.0	CE-459	Concrete Technology-II	3.5
BS-102	Mathematics-II	4.0	CE-515	Highway Engineering	3.0
BS-104	Physics	1.0	CE-526	Soil Engineering-I	3.5
CS-105	Chemistry	1.0	CE-535	Irrigation & Hydrology	3.0
CS-107	Computer Science	3.0	EE-536	Electrical technology-II	3.5
CE-108	Engineering Mechanics	3.0	CE-554	Theory of Structures-III	3.0
CE-110	Engineering Drawing-I	3.0	BS-556	Engineering Geology	2.5
BS-203	Mathematics-III	3.5	CE-560	Concrete Technology-III	3.5
CE-220	Survey Engineering-I	4.0	AE-609	Architecture & Town Planning	2.0
CE-225	Strength of Materials-I	4.0	CE-611	Engineering Drawing-II	2.0
CE-230	Hydraulics-I	3.0	CE-618	Air Transportation Engineering	2.5
CE-233	Engineering Materials	2.0	CE-627	Soil Engineering-II	4.0
CE-237	Water Supply	2.5	ME-638	Mechanical technology	2.5
HU-317	Pakistan Studies	1.5	CE-661	Concrete Technology-IV	4.0
CE-312	Survey Engineering-II	2.0	CE-662	Steel Structures	4.0
CE-326	Strength of Materials-II	4.0	HU-706	Islamic Studies	1.0
CE-331	Hydraulics-II	4.0	CE-712	Building Construction & Estimation	3.0
CE-332	Sanitary Engineering	3.0	PM-713	Project Management	3.0
CE-352	Theory of Structures-I	4.0	CE-714	Transportation (Railway & Coastal)	2.0
CE-358	Concrete Technology-I	3.0	CE-728	Soil Engineering-III	2.5
BS-416	Numerical Analysis	3.0	CE-763	Design of Structure (Steel)	2.5
CE-422	Survey Engineering-III	3.0			
CE-427	Strength of Materials-III	3.5	CE-764	Design of Structure (Concrete)	2.5
EE-435	Electrical Technology-I	2.5	CE-790	Individual Project	2.0
CE-453	Theory of Structures-II	4.0		<b>Total Credits Required</b>	<b>140.5</b>

a) **MS Geotechnical Engineering:** The course focuses on strengthening students' knowledge in geotechnical engineering and exposing them to issues related to engineering geology, geotechnic, foundation engineering, geological and rock engineering, hydrology, soil structure and pavement design/analysis/rehabilitation (Table 2).

b) **MS Structural Engineering:** The course focuses on solution of problems in structural engineering by enlarging and deepening students' knowledge; thus emphasizing that they have a good grasp of new design concepts and technologies. The course contents encompass advance techniques for structural analysis, structural dynamics, reinforced concrete structures, and analysis and design of pre-stressed concrete structures (Table 2).

c) **MS Transportation Engineering:** The postgraduate program in transportation engineering focuses on solving civil engineering problems in the context of transportation issues. The program concentrates on practical oriented problems concerned with structural, transportation,

traffic and highways/airport engineering. The curriculum aims at encouraging the intellectual pursuit of creative ideas to improve human and natural environments (Table 2).

**Table 2** MASTERS OF CIVIL ENGINEERING CURRICULUM

a) GEOTECHNICAL ENGINEERING			c) TRANSPORTATION ENGINEERING		
Course	Course Title	Credits	Course	Course Title	Credits
CE-801	Pavement Design & Analysis	3.0	CE-801	Pavement Design & Analysis	3.0
CE-821	Soil & Site Improvement	3.0	CE-803	Pavement Materials Engineering	3.0
CE-822	Rock Mechanics-I	3.0	CE-808	Airport Engineering	3.0
CE-826	Mechanical Properties of Soils	3.0	CE-821	Soil & Site Improvement	3.0
CE-802	Pavement Rehabilitation	3.0	CE-802	Pavement Rehabilitation	3.0
CE-823	Rock Mechanics-II	3.0	CE-806	Geometric Design of Highways/Freeways	3.0
CE-827	Advanced Geotechnical Design	3.0	CE-807	Traffic Engineering	3.0
CE-828	Earth Structure	3.0	CE-828	Earth Structures	3.0
CE-899	Master's Thesis Research	6.0	CE-899	Master's Thesis Research	6.0
<b>Total Credits Required</b>		<b>30.0</b>	<b>Total Credits Required</b>		<b>30.0</b>
b) STRUCTURAL ENGINEERING			d) ENVIRONMENTAL ENGINEERING		
Course	Course Title	Credits	Course	Course Title	Credits
CE-852	Concrete Materials & Technology	3.0	ENE-501	Environmental Chemistry	3.0
CE-854	Matrix Structural Analysis	3.0	ENE-502	Environmental Microbiology	3.0
CE-859	Advanced Concrete Design	3.0	ENE-503	Environmental Measurements-I	1.0
CE-861	Steel Structure	3.0	ENE-504	Hydraulics	3.0
CE-862	Reinforced Concrete Members	3.0	ENE-505	Mathematical Modeling of Environmental Systems	3.0
CE-825	Deep Foundations	3.0	ENE-506	Hydrology	3.0
CE-858	Structural Dynamics & Seismic Analysis	3.0	ENE-507	Water Treatment & Distribution	3.0
CE-856	Pre-stressed Concrete Structures	3.0	ENE-508	Wastewater Collection & Treatment	3.0
CE-857	Finite Element Method	3.0	ENE-509	Environmental Measurements-II	1.0
CE-899	Master's Thesis Research	3.0	ENE-601	Solid & Industrial Waste Management	3.0
<b>Total Credits Required</b>		<b>33.0</b>	ENE-602	Air & Noise Pollution Control	2.0
			ENE-603	Environmental Policy & Planning	2.0
			ENE-899	Master's Thesis Research	6.0
			<b>Total Credits Required</b>		<b>36.0</b>

d) MS Environmental Engineering: In pursuance of commitment to provide cost effective engineering solutions to a variety of national problems, the Institute of Environmental Science and Engineering (IESE) was established to deal with the environmental pollution issues in the country. It offers postgraduate degree in the field of Environmental Engineering, with special

reference to environmental problems of Pakistan. The institute is equipped with the modern environmental labs.

The salient features of the institute are, a curriculum based on that of Michigan State University (MSU), USA, with special reference to environmental labs, a well stocked library and excellent computer facilities with email/internet access through LAN (Table 2). Close contacts with environment related national and international agencies (Government, Non-governmental organizations, Industry etc) exist. Students showing academic excellence get a chance to complete their degree in USA or Australia.

The academic degree program spreading over 18 months consists of 4 semesters. In the first 3 semesters following subjects are taught through lectures, assignments and quizzes: environmental chemistry and microbiology; hydraulics and hydrology; municipal and industrial waste collection; treatment and disposal; air and noise pollution control; modeling of environmental system, environmental policy and planning etc. The theoretical knowledge is supplemented by rigorous laboratory work, spread over two semesters under the keen supervision of qualified highly experienced faculty of the institute.

### **Layout of Civil Engineering Program**

An outstanding feature of the university is that while maintaining traditional values of excellence in teaching and research. It challenges the conventional practices and creates new ways of developing and delivering courses on the most modern lines.

Bachelor's degree program in Civil Engineering requires a minimum of 128 credit hours course-work spread over a stipulated period of three and half years with slight variations. Students entering this program are required to have a minimum qualification of Higher Secondary School Certificate (HSSC), Pre-Engineering or equivalent years of successful education.

Master's degree in specialized areas within Civil Engineering require minimum of 30 credit hours, including 6 credit hours of thesis in a stipulated period of 18 months. The course contents are spread over four semesters of 16 weeks each. The courses are distinctive, being qualitative in nature and in accordance with the international standards. A student with a minimum GPA of 3.0, at the end of the course work is allowed to undertake thesis to earn MS Engineering degree by successfully defending the dissertation.

The 18 months duration of MS courses is divided into academic segments as under, (though there may be minor changes depending on specific requirements/circumstances).

• Pre-course studies (Zero Semester)	- 4 to 6 weeks
• First Semester	- 16 weeks
• Break	- 2 weeks
• Second Semester	- 16 weeks
• Break	- 4 weeks
• Third & Fourth Semester (Thesis work of 6 credit hours)	-35 weeks

The department also runs postgraduate programs in various Civil Engineering disciplines. The doctoral program consist of a minimum of 30 credit hours of 800/900 level course work and 30 credit hours of thesis research. Its minimum duration is 3 years. Selected Ph.D. students are provided teaching/research assistantship for sponsored projects during the course of their study.

## **University of Florida**

### **Introduction**

University of Florida (UF) is one of the America's truly distinctive universities. Along with Ohio State and the University of Minnesota, UF offers more academic programs on a single campus than any of the nation's other universities, private and public. Being among the nations 20 largest universities, its division into colleges and school gives students the opportunity to know and work closely with classmates and teachers. UF serve the needs of the nation and the state of Florida through its common pursuit of its three-fold mission of education, research and service. It serves the purpose, by pursuing and disseminating new knowledge while building upon the past. It aspires to further national and international recognition for its initiatives and achievement in promoting human values and improving the quality of life.

### **Civil Engineering Undergraduate Studies Program**

The primary objective of the Civil Engineering curriculum at the UF is to accomplish three primary purposes:

- 1) To provide a broad general education, which enhances communication skills and encourages all-around development of students, both individually and as productive members of society,
- 2) To ensure a thorough preparation in the fundamentals of science and engineering, and
- 3) To provide a foundation to the planning, design, construction, and operation of civil engineering projects.

Civil Engineering program at the UF consists of a combination of laboratory and lecture courses. UF facilitates an environment for students to experience a comprehensive engineering education that is competitive with other universities globally.

A bachelor's degree in Civil Engineering at the UF is broken down into two phases: general education/pre-professional and upper division. During the first two years, students take general college and pre-professional courses. Once having completed approximately 64 credit hours, students apply to their desired field, within the Department of Civil and Coastal Engineering.

The curriculum has been accredited and approved by standards set by the American Board of Engineering Technology (ABET). In addition, students are encouraged to participate in professional societies and involve themselves with hands-on projects competition. These competitions allow students to utilize the skills that they have obtained in the classroom, to design and build steel bridges and concrete canoes.

The Civil Engineering undergraduate curriculum is a diversified mixture of classes in the areas of construction, geomatics (surveying and mapping), geotechnical, hydraulics, hydrology/water resource, materials, public works, structure and transportation. The undergraduate program is ideally a 9 terms, 131-credit hour program. In the students' last semester, they are required to choose at least 2 courses, which can serve either as technical or design electives. These

design/technical elective courses allow students to concentrate in a specific area of civil engineering discipline (Table 3).

**Table 3** PLAN OF STUDY, CIVIL ENGINEERING, UF

<b>TERM 1</b>			<b>TERM 2</b>		
<b>Course</b>	<b>Course Title</b>	<b>Credits</b>	<b>Course</b>	<b>Course Title</b>	<b>Credits</b>
MAC 2311	Analytical Geom. & Calculus 1	4.0	MAC 2312	Analytical Geom. & Calculus 2	4.0
CHM 2045	General Chemistry 1	3.0	CHM 2046	General Chemistry 2	3.0
CHM 2045L	General Chemistry Lab	1.0	PHY 2048	Physics with Calculus 1	3.0
Gen. Ed. (Hum)	Humanities	3.0	PHY 2048L	Physics Lab	1.0
Gen. Ed.- (Social Sciences)	Social & Behavioral Science	3.0	ENC 3254/2210	Speaking & Writing for Eng. / Technical Writing	3.0
<b>TERM 3</b>			<b>TERM 4</b>		
<b>Course</b>	<b>Course Title</b>	<b>Credits</b>	<b>Course</b>	<b>Course Title</b>	<b>Credits</b>
MAC 2313	Analytical Geom. & Calculus 3	4.0	MAP 2302/EGM 3311	Differential Equations or Intro to Engineering Analysis	3.0
PHY 2049	Physics with Calculus 2	3.0	EGM 2511	Statics	2.0
PHY 2049L	Physics Lab	1.0	Gen. Ed. (Hum/S)	Humanities or Social Science	3.0
Gen. Ed. (Hum)	Humanities	3.0	Gen. Ed. (B)	Biological Science Elective	3.0
Gen. Ed. (S.S.)	Social & Behavioral Science	3.0	SUR 2101C	Geomatics	3.0
<b>TERM 5</b>			<b>TERM 6</b>		
<b>Course</b>	<b>Course Title</b>	<b>Credits</b>	<b>Course</b>	<b>Course Title</b>	<b>Credits</b>
EGM 3520	Strength of Materials	3.0	EGM 3400	Concrete Technology-IV	4.0
CES 3102	Mechanics of Engineering Structures	4.0	CGN 3501	Civil Engineering Materials	4.0
SUR 2322C	Project Development Visualization	3.0	CEG 4111	Soil Mechanics	1.0
CGN 4101	Civil Engineering Cost Analysis	2.0	CES 4141	Stress Analysis	3.0
EML 3007/3100	Thermodynamics	3.0	CGN 3421	Computer Program for Civil Engineering	3.0
<b>TERM 7</b>			<b>TERM 8</b>		
<b>Course</b>	<b>Course Title</b>	<b>Credits</b>	<b>Course</b>	<b>Course Title</b>	<b>Credits</b>
CWR 3201	Hydrodynamics	4.0	CWR 4202	Hydraulics	3.0
CGN 3710	Experimentation & Instrumentation in Civil	3.0	CES 4702	Analytical & Design in Steel	3.0

	Engineering				
CES 4702	Analytical and Design of Concrete	3.0	CCE 4204	Construction Method & Management	3.0
CEG 4012	Geotechnical Engineering	3.0	EGN 4032	Professional Issues in Engineering	3.0
			SUR 4201	Route Geometrics	2.0
			SUR 4201L	Route Geometrics Lab	1.0
<b>TERM 9</b>					
<b>Course</b>	<b>Course Title</b>	<b>Credits</b>			
CWR 4111	Hydrology	3.0			
CWR 4812	Water Resources or ENV 4514	3.0			
TTE 4811/4004	Physical Design Transportation Facilities/ Transportation Engineer	3.0			
Elective	Design Elective	3.0			
Elective	Technical or Design Elective	3.0			
				<b>Total Credits Required</b>	<b>131.0</b>

### Graduate Studies Program

The graduate program allows students to concentrate in a particular field of interest in the civil engineering department.

a) Construction Engineering: The construction engineering/engineering management graduate program explores the latest technique in construction engineering and civil engineering management. It has a combination of courses in general civil engineering practice and business administration with a balance of design, analytical and business courses.

b) Geotechnical Engineering: The geotechnical program concentrate it course work in structural foundations, interaction of structure with soil, construction of excavations and embankments, earth dams and levees, stability of slopes and control of groundwater and seepage.

c) Hydraulics: It is oriented towards the many water-related problems of the US, particularly the southeastern United States. The courses place special emphasis on the hydrodynamics and optimum management of surface waters and groundwater.

d) Hydrology/Water Resource Engineering: The hydrology graduate program emphasizes research and engineering practice in solving water resource problem, dealing with groundwater resource development, contaminant transport and remediation, surface-water runoff and drainage, and the interaction between surface-water and groundwater systems including lake



studies. Florida's hydrologic system provides many unique opportunities for research and training in these areas.

e) **Materials:** The graduate materials curriculum is design to provide students with the theory of behavior, design, and evaluation of composite materials (e.g. concrete and asphalt mixture) with some emphasis on construction techniques and quality control.

f) **Public Works:** The public works engineering graduate program composes of planning, design, construction and management of public facilities and services. Engineering practice in the broad spectrum of public works development provides student with competency skills in public administration, urban planning, social science and management. The program integrates an interdisciplinary core-encompassing course in public administration, public works management, and the public works design process, with advanced work in such traditional areas of engineering practice as construction, environmental design, transportation, and water resources.

g) **Structural Engineering:** The structural engineering program is a balanced one, emphasizing analysis, design, and behavior. Course works for structural student are available in engineering science and mechanics, geotechnical, construction, management, mathematics and statistics to round out the student's program. Some emphasis is placed on offshore structures, with aspects that include submarines soils mechanics, soil-structure interaction, interaction of waves and currents with structures, structural dynamics and structural design.

h) **Geomatics:** The Geomatics (Surveying and Mapping) graduate program is designed for students desiring additional study in the areas of land information systems, photogrammetry, remote sensing, and geographical information systems (GIS), geodesy etc.

i) **Transportation Engineering:** The graduate traffic-engineering curriculum focuses on operational analysis of transportation systems, and urban transportation planning. It stresses on the application of a broad range of disciplines to the solution of problems in these areas. More detailed information about the graduate fields and courses for civil engineering can be found on UF's webpage for the Department of Civil Engineering.

### **Comparison of Civil Engineering Curriculum**

The major curriculum of each school differs based on their socio-economical characteristics, national and industrial needs, and the availability of natural resources. In Pakistan, agriculture and irrigation has a great influence on the economy of the country. Therefore civil engineering curriculum at the NUST focuses to cover aspects related to it. From groundwater to environmental concerns, and from construction to transportation, all avenues are taught as a part of it. The aim is to make a definite contribution towards solving the real life problems, being faced by the local industry and community.

At the UF civil engineering program and curriculum permit its graduates to enter industry and commence life-long learning through professional activities or graduate studies. The objective is to enhance contributions to the State, nation, and profession through strong programs in teaching,

research and service. Civil Engineering Department at the UF also offers courses in coastal engineering, as beaches in the State of Florida are a great attraction for the tourists. Thus the proper maintenance and public welfare requires incorporation of engineering approach to keep the economy stable, and places safe for general use. Being a developed country, the ever rising demand to be consistent with the technological advancements play a pivotal role in the dissemination of engineering education.

Graduates from the UF when step out to serve the nation, are competent enough to work under different environments and are successful in all walks of life. They get hired in various positions from being in the administration division to being a construction engineer in the field. Different state agencies and private companies tend to absorb the qualified students. Whereas in Pakistan, the stereotypical attitude towards the engineers exists, which is now changing. Though they are considered the builders of the nation, administration and engineering are considered to be two completely different things. This behavior is now changing as the people are getting more educated.

UF offers its students a choice by which students have an option of selecting certain courses. The only limitation is the courses being taken should be able to count towards their degree and must be acceptable by the department. On the other hand, in undergraduate level at NUST, all students study the same courses. The only liberty students have is that they can choose their field of interest at the graduate level, but still need to follow the set designed curriculum. This difference has not yet been quantified, but obviously is quite prominent in terms of the student outcomes relative to recruitment and retention. One can feel the difference as by giving students a choice, you are providing ways to help create diversity in the graduates, in terms of experience and backgrounds.

Although the overall curriculum structure may appear different but the basic underlying objective of academic syllabus is the same. This common objective is basically the result of increasing global nature of Civil Engineering education. Undoubtedly, the future of Civil Engineering education strives on the balance of ideas from global perspectives. Keeping in mind the interests that each University serves, the UF is trying to make courses in specialized fields within Civil Engineering more specific, making students to focus on only the field of interest in their last semesters. While in order to fulfill the ever increasing challenges of the future, NUST needs to have an educational curriculum where students have an option to select few core courses in a specific field, which are of interest to the student.

## **Conclusion**

Comparing the curriculum of the two Universities, the Civil Engineering education at the UF primarily focuses on technical excellence, communication skills, and a well-rounded general and interdisciplinary education. It is energized with a vision for future, and is committed to academic provisions aimed at intellectual leadership and distinction in its teaching programs. In comparison, NUST focuses on balanced distribution of theoretical knowledge, practical and fieldwork to address real life civil engineering projects. With the development of envisaged infrastructure coupled with modern tools of learning/research and the diversity of academic programs, the institute is well on its way to combat the challenges of the millennium.

The optimistic approach towards adding more to its present curriculum, by each University is highly appreciable. Although the intensity of changes may differ, at each institutional level based

on their socio-economical traits, national needs, industrial demands, and the availability of natural resources.

### **Reference**

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