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## CONTENTS OF WIRELESS NETWORKING COURSES IN ASTRONOMY AND SPACE SCIENCE CURRICULA IN PAKISTAN

### *Abstract*

*In all the eras of known human civilization, the role of Astronomy and space sciences has been dominant. Because of their specific role in human social activities related to religions and rituals these sciences procured leading position. In modern days too, the countries who are leaders in Astronomy and Space Science are leading the world. Unfortunately our country is still far behind in these areas, consequently far behind in scientific and social development. Wireless communication is the fastest growing segment of the communication industry that has captured the attention of media and the imagination of public. Requirement for multi applications and demand for wireless connectivity is now at its highest which has to be accomplished to satisfy the need of every user. In the following a review of topics related to wireless networking as included in space science and astronomy curricula in Pakistan is presented. In this study we are going to analyze the curriculum of space sciences along with wireless networking in all around the institutions in Pakistan. A comparison with international standards will be provided to discover the level of these curricula.*

**Keywords:** *Wireless networking, Space sciences, Curriculum, Comparison.*

### *Introduction*

It is obvious that utilization of space sciences and technology for the development is open to every nation and region. It is very

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important to put such efforts that make general awareness in masses globally. This will increase the chances of beneficial use of space science and technology. Obviously education and proper training are the factors sufficient to manage accordingly.

This study provides a comparison of space science and telecommunication curricula adopted by different institutions in Pakistan. In view of the critical role of wireless networking technology and its role in telecommunication industry, it is obvious that it had been the part of space science curricula since the early stages.

But in the beginning the space science curricula greatly lacked the wireless networking technology as an independent subject. It was possible only in early 60's that space sciences institutions understood the importance of including such courses at various levels of their curricula. And now the proportion of wireless networking technology has been increased up to some standard level.

### *History*

The first artificial satellite sputnik-1 was launched in 1957 and Apollo-11's landed on moon in 1969, these are the spectacular achievements that satisfied the human quest to reach out in to vast outer space. During fifty years since the beginning of space age, space based assets and their applications have brought so many opportunities which have made the profound change and quiet revolution in the world where we live today. There are 900 satellite in the space which are operated by almost more than 40 countries and 7000 satellite have been launched since the beginning of space age (suparco, website).

“Space based assets have become an indispensable to modern life whether it is a telecast of events around the world or beyond, satellite whether forecasting, the telecommunication revolution, mapping, minerals exploration, water resources management, disaster mitigation, national security or hundreds of other applications, life with these would be quite difficult.”

### *Pakistan's need for Space Sciences Capability and Telecommunication*

"Spaced based communication system offers fast and affordable means of providing services like tele-education, tele-medicine, mobile telephony and television to almost everywhere. Communication via satellites provide an important and essential communication medium to armed forces also. Remote sensing satellites have great potential in contributing to better land management, food security, disaster management, urban planning, mineral exploration, crops yield forecasting e.t.c. Telecommunication deals with many important and fundamental requirements of our country such as data communication, broad casting, internet and the development of radio frequency and data subsystem. The development of high speed broadband wireless techniques such as MIMO-OFDM have led to the birth of wireless sensors network (WSN)(suparco, website). Wireless sensor network has a very vast range of utilization such as defense reconnaissance, surveillance, intrusion detection, safety, health care and environment monitoring."

#### *Background*

Space science and research wing of Pakistan Atomic Energy Commission (PAEC) was established in 1961 which was later renamed as a Pakistan Space and Upper Atmosphere research committee (SUPARCO) and Prof. Abdul Salam was appointed as a chairman. In 1981 it was granted the status of a commission.

In 1984, the long term space science and technology development programme was launched which consisted of four basic component;

- i. Establishment of ground stations.
- ii. Establishment of Satellite tracking facilities.
- iii. Launching of multipurpose satellites.

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- iv. Development of Satellite and complete satellite launch vehicle manufacturing.

After the introduction rest of the paper is organized as follows. First, the curriculum of space sciences and wireless telecommunication of different renown institution of Pakistan are discussed and compared with some international institutions. The study will be finalized by a concluding discussion.

### *Space Science Curricula in Pakistan*

#### *Curricula of Space Science proposed by Higher Education Commission (HEC) Pakistan*

University grants commission of Pakistan is an institution which controls a quality and standards of the curriculum to be opted by the institutions of higher learning in Pakistan. In the following the structure of curricula as suggested by HEC Pakistan is provided (HEC, website)

- Fundamentals of remote sensing
- Atmospheric sciences
- Spherical Astronomy and Geodesy
- Gravitational Physics
- Astronomy
- Statistical and Space Plasma Physics
- Space Flight Dynamics-I
- Solar and Inospheric Physics
- Digital Image Processing
- Meteorology
- Astrophysics
- Space Flight Dynamics-II
- Analog and Digital Electronics
- Navigation and Space Instrumentation
- Space Mission Design

### *Electives Courses*

#### *i. Geo Informatics (GI)*

- Remote Sensing Applications
- Geo Informatics for Environmental applications
- GIS Customization for Web Based applications
- Decision Support System
- Natural Resource Management
- GIS for Urban Planning
- Disaster Monitoring and Management
- Air and Space-Borne Sensors
- Photogrammetry Analysis
- Special Topics in Geo Informatics

#### *ii. Atmospheric and Environmental Sciences (AES)*

- Weather Analysis and Forecasting
- Numerical Weather Modeling and Prediction
- Radar/Satellite Meteorology
- Atmospheric Dynamics
- Climate Change
- Atmosphere Phenomena Modeling
- Geomagnetism and Seismology
- Oceanography and Ocean Wave Dynamics
- Physics and Chemistry of Aerosols
- Physics and Chemistry of Upper Atmosphere
- Special Topics in Atmospheric Sciences

#### *iii. Satellite and Space Communication (SSC) 34*

- Radar Technology
- Data Communication and Networks
- Navigation and Satellite Positioning
- RF Engineering
- Analog and Digital Signal Processing
- Advanced Orbital Mechanics

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- Space Medicines and Life Support Systems
  - Spacecraft System Engineering
  - Satellite Communication Systems
  - Satellite Launch Systems
  - Software Defined Radio
  - Guidance, Navigation and Control Systems
  - Rocket and Spacecraft Propulsion
  - Material Applications for Space Technology
  - Astrobiology and Extraterrestrial Life
  - Special Topics in Space Systems

#### **iv. *Space Physics (SP)***

- Astrophysical Techniques
- Solar System Astrophysics
- Stellar Astronomy
- High Energy Astrophysics
- Magneto spheric Physics
- Plasma Dynamics
- Analysis and Interpretation of Space Data
- Radio Astronomy
- Computational Astrophysics
- Electrodynamics
- Cosmology
- Asteroids, Meteorites, Comets
- Solar-Terrestrial Physics
- Magneto hydrodynamics (MHD)
- Vacuum Science and Technology
- Special Topics in Astronomy/ Astrophysics: Seminars

#### ***Curriculum for the Telecommunication by HEC (HEC, website)***

##### ***i. Core Courses***

- Stochastic Processes
- Telecom Systems & Networks
- Advanced Digital Communication

*ii. Specialization (Communication System)*

- Optical Fiber Communications
- Advanced Computer Networks
- Advanced Wireless Communication
- Telecom Management Network
- QOS in Telecommunication Networks
- Telecom Policies and Regulations

*iii. Specialization (Signal Processing)*

- Advanced Digital Signal Processing
- Adaptive Signal processing
- Real Time DSP
- Digital Image Processing
- Statistical Signal Processing
- Video Signal processing
- Speech Processing

*iv. Specialization (RF & Wireless Communication)*

- Antenna Design
- Microwave Engineering
- Advanced Engineering Electromagnetic
- Radar Engineering.
- Advanced Wireless Communication
- Mobile Communications
- Satellite Communication

*v. Specialization (Telecommunication Networks)*

- Mobile Ad-hoc Networks
- Optical Communication & Networks
- Advanced GSM Architecture
- Telecom Management Network
- Broadband Communication
- SS7 & Intelligent Networks

- CDMA based Networks
- Network Security
- Next Generation Networks
- Sensor Networks

*vi. Electives*

- Research Methodology
- Simulation and modeling
- Operational Research”

*Courses Offered by Department of Space Sciences University of Karachi (ISPA)*

University of Karachi is one of the leading universities of Pakistan and is prominent in the sense that it is the first institution in Pakistan to establish a full-fledged institution for space science studies. With the main task of advanced research, graduate studies of the level of MS/Ph.D. and postdoctoral research it is called Institute of Space and Planetary Astrophysics (ISPA) (uok, website)

*Graduate Curricula*

- i. “First Semester**  
Spherical Astronomy and Geodesy  
Foundation of Remote Sensing  
Statistical Methods
  
- ii. Second Semester**  
Astronomy  
Geographical Information Science  
Atmospheric Science
  
- iii. Third Semester**  
Atmospheric Dynamics  
Space Flight Dynamics  
Quantum Mechanics  
Optional Subject-I  
Optional Subject-II

**iv. Fourth Semester**

- Solar and Ionosphere Physics
- Astrophysics
- Gravitation Physics

***Optional Subjects for Third Semester (Optional Subject-I & II)***

- Cosmology
- Statistical Physics and Space Plasma
- Global Positional Systems
- Navigation & Space Instrumentation
- Space and Satellite Communication
- Fundamentals of Physical Oceanography

***Optional Subjects for Fourth Semester (Optional Subject-III & IV)***

- Space Mission Design
- Air & Space-borne Sensors
- Aerospace and their Applications
- Environmental Science
- Renewable Energy Resources
- Coastal Zone Management
- Natural Hazards and Disaster Management
- Projects
- Thesis

***Space Science Curricula of the University of Punjab***

The University of Punjab has a department of space science which runs an M. Phil. and several under graduate programs in space sciences (Space-Science, website). The curricula followed are given below.

***MS. Curriculum***

- “Modeling Techniques/Advance Application in Remote Sensing
- Flight Dynamics

- Astrodynamics
- Space Systems and their Applications
- General Relativity & Gravitation
- Relativistic Quantum Mechanics
- Geodesy and GPS
- Cartography/Thesis/Internship

### ***BS. Curriculum***

- Atmospheric Science
- Solar System Astronomy
- Electricity and Magnetism
- Physics Lab-II
- Calculus-II
- Mechanics and Vector Analysis
- Fundamentals of Rockets
- Astrophysics & Geomagnetism
- Waves and Oscillations
- Modern Physics
- Meteorology
- Fundamentals of Communications
- Electronics
- Aerospace Systems
- Remote Sensing-I
- Analog Electronics
- Mathematical Techniques
- Special Theory of Relativity
- Climatology
- Remote Sensing-II
- Digital Electronics
- Cosmology and Space Plasma
- Fundamentals of Geology
- Practicals in Image Interpretation
- Weather Analysis and Forecasting
- Telecommunications
- Image Processing
- Riemannian Geometry"

### *Space Science Curricula of Institute of Space Science and Technology (1<sup>st</sup>)*

The institute offers bachelors and masters level programs in space science and technology and MS in Communication Engineering (**Wireless Communications**). Which is an indigenous MS program started by IST. This versatility of this program gives extensive knowledge of terrestrial and space communication (ist, website). With the changing trends of the market, this course will enhance the capability of candidates accordingly.

IST also offers the degree of Bachelor of Science (BS) in Space Science. The focus is on the following.

- “Space/ Satellite Communications
- Astros dynamics / Astronautics
- Different subsystems of spacecraft/ satellite
- Remote Sensing/ GIS techniques
- Space/ Earth data processing/ analysis techniques
- Meteorology, Atmospheric and Environmental Sciences
- Space Flight Dynamics-I
- Digital Image Processing
- Analog and Digital Electronics
- Navigation and Space Instrumentation
- Space Flight Dynamics-II
- Communication Networks
- Satellite Communications
- Space Mission Design
- Embedded System in Space

### *For Telecommunication*

- Space Physics including Astronomy and Astrophysics
- Signal and Image processing
- Advanced Digital Signal Processing
- Advanced Digital Communications
- Advanced Wireless Communications
- Mobile Communications

- Satellite Communications
- Stochastic Processes
- Pattern recognition

### *Electives in Communication Engineering*

- Digital Signal Processing
- Telecommunication Management
- Multimedia Communication
- Microwave Devices
- Digital Communications
- Antennas & Propagation
- Transmission & Switching Systems
- Mobile Communications
- Satellite Communications
- Radar Systems
- Optical Communications
- Spacecraft Engineering"

For the comparison purpose, space science curricula with stress on wireless communication curricula of one American and one British university are given in the following

### *Curriculum of Telecommunication by Columbia University of New York*

"The ties between Columbia University and New York City predate even Columbia College's 1754 founding as King's College. Fifty years before King George II of England granted the royal charter that designated "The College of the Province of New York, in the City of New York ... known by the name of King's College," one early proponent wrote to the Anglican church, "New York is the center of English America and a fit place for a College." The institute offers the following courses (Columbia, website),

- Introduction to Genomic Information Science and Technology

- Signals and Systems Laboratory
- Introduction to Communication Systems
- Signals and Systems
- Fundamentals of Computer Systems
- History of Telecommunications: From the Telegraph to the Internet
- Communication Circuits
- Sensors, Actuators and Electromechanical Systems
- Digital Control Systems
- Communication Theory
- Wireless Communications
- Digital Signal Processing
- Random Signals and Noise syllabus
- Advanced Logic Design
- Digital Systems Design syllabus
- Digital Image Processing
- Advanced Communication Circuits
- Optimal Control Theory
- Stochastic Models in Information Systems
- Advanced Digital Signal Processing
- Telecommunication Network Control and Management
- Wireless and Mobile Networking, I
- Wireless and Mobile Networking, II
- Multimedia Networking syllabus
- Resource Allocation and Networking Games syllabus
- Distributed Telecommunications Systems: Fundamentals and Programming"

### *Space Sciences Curricula of University of Surrey*

"Learning at the university of Surrey is excellently placed to keep pace with the rapidly evolving field of modern technology. A specialism in electrical engineering will give you the opportunity to address the great demand for highly skilled electrical (power and control) engineers worldwide (surrey, website).

- Computer Vision and Pattern Recognition
- Control Engineering

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- Data and Internet Networking
  - Digital Communications
  - Digital Signal Processing
  - Electrical Machines and Power Systems
  - Multimedia Systems and Component Technology
  - Nanoscience and Nanotechnology
  - Object-Oriented Design and C++
  - Optoelectronics
  - Power Electronics
  - RF and Microwave Fundamentals
  - Silicon Devices and Technology
  - Space Missions
  - Spacecraft Bus Subsystems
  - Advanced Guidance, Navigation and Control
  - Advanced Signal Processing
  - Antennas and Propagation
  - Artificial Intelligence and AI Programming
  - Electrical Power Engineering
  - Image and Video Compression
  - Launch Vehicles and Propulsion
  - Materials for Energy Generation and Storage
  - Microwave Engineering Principles
  - Mobile and Personal Communications
  - Molecular Electronics
  - Nano-electronics and Devices
  - Nanofabrication and Advanced Experimental Methods
  - Networks and Control
  - Operating Systems for Mobile Systems Programming
  - Principles of Telecoms and Packet Networks
  - RF Systems and Circuit Design
  - Satellite Communications
  - Satellite Remote Sensing
  - Space Robotics
  - Spacecraft Systems and Design
  - Speaker and Speech Recognition
  - Speech and Audio Processing and Coding"

### *A Comparative Study*

The following table compares the weight allocated to wireless telecommunication studies in the space science curricula of local and foreign institutions.

Table 1 shows the comparison between institutions

S.no	Course Name	HEC	University of Punjab	University of Karachi	STI	Columbia University	University of Surrey
1.	Remote sensing	Yes	Yes	Yes			Yes
2.	Image processing	Yes	Yes		Yes	Yes	
3.	Data communication	Yes				Yes	
4.	Satellite Communication	Yes	Yes	Yes	Yes		Yes
5.	Telecom Networks	Yes	Yes		Yes		
6.	Signals processing	Yes			Yes	Yes	Yes
7.	Wireless Communication	Yes	Yes		Yes	Yes	
8.	Mobile Communication	Yes			Yes	Yes	Yes
9.	Mobile Ad-hoc Networks	Yes					
10.	Sensors Network	Yes				Yes	
11.	Digital Processing	No			Yes		

### *Proportion of Wireless Technology Courses in Space Science Curricula*

The following diagram represents the proportion of wireless technology courses in space sciences,

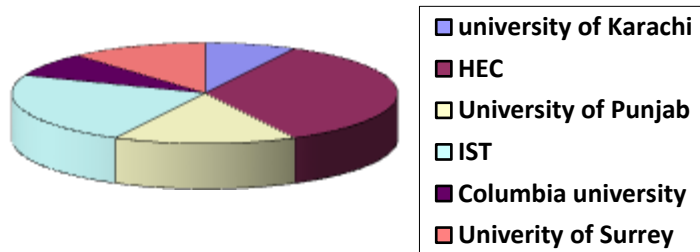


Figure1 Calculates the proportion of wireless communications courses in space science curricula among all the institutions

According to HEC course outline it appears that the course contents related to telecommunication poses a satisfactory position in local universities. According to telecommunication course contents the curricula of Punjab university are at the first place, than IST and university of Karachi. It appears that ISPA university of Karachi has more stress on space science contents and the courses are of the standard of Ph.D. and MS level and also they have stressed upon producing PhDs. Whereas university of Punjab, in view of its market value put more stress on telecommunication courses. IST stresses much upon engineering areas, particularly on communication engineering. HEC Pakistan has also performed job of monitoring the curricula well. Courses suggested by HEC are versatile, innovative and fulfill the need of the market.

### ***Conclusion***

Comparing with the foreign institutions it can be concluded that the local institutions sufficiently meet the international standards as is obvious from table 1 and figure 1.

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