NEW ZEALAND INSTITUTES OF TECHNOLOGY AND POLYTECHNIC QUALIFICATIONS IN INFORMATION & COMMUNICATIONS TECHNOLOGY

PRESCRIPTION: MW600 MOBILE WIRELESS PRINCIPLES

AIM OF MODULE:	Students will gain an understanding of the principles utilised in the transmission of signals by mobile wireless systems.
CREDITS:	14
STUDENT LEARNING HOURS:	140
CONTENT REVISED:	2008
PRESCRIPTION EXPIRY DATE:	Nov 2011

Level and Assessment Schedule

TOPICS	Highest Skill Level R	C	A	P	Suggested Assessment Percentage
1. Frequency bands & units of measurement			*		10
2. Signal encoding and modulation techniques			*		35
3. RF Transmission Lines			*		15
4. RF propagation		*			5
5. Aerials		*			10
6. Spread Spectrum techniques		*			15
7. Error control		*			5
8. Infrared Wireless LAN		*			5
					100

LEARNING OUTCOMES

The student will:

A	1.	Describe the Electromagnetic spectrum, the allocation of frequencies to the various services and use logarithmic units to measure system gains and losses.
A	2.	Investigate and explain encoding techniques used for analogue signals and techniques for modulating radio carrier frequencies and demonstrate the operation of simple modulation devices.
A	3.	Describe RF transmission lines, and their properties, as they apply to radio frequency transmission and measure signal levels on a RF transmission line.
C	4.	Describe the various signal propagation modes and explain how they are affected by the ionosphere and terrestrial conditions.
C	5.	Investigate and describe the construction of basic aerials and explain their radiation patterns.
C	6.	Describe and explain the concept of Spread Spectrum techniques.
C	7.	Explain error detection and correction techniques as used in mobile wireless applications.
C	8.	Describe Infrared transmission techniques and how these are applied to LAN's.

CONTENT

1. Frequency Bands & Units of Measurement

- A description of the electromagnetic spectrum and the allocation of frequencies to various services will include;
  - frequency bands and their typical application
  - services that are suited to higher frequency bands
- An explanation of the application of logarithmic units for the measurement of RF systems gains and losses will include;
  - describing the advantages of the system of logarithmic-based units
  - defining a decibel as a logarithmic power ratio and expressing the levels in decibels relative to 1 mW
  - calculating losses and gains in a system using measured power, voltage and current

2. Signal Encoding and Modulation Techniques

- An explanation of signal encoding techniques will include;

a) Continuous wave modulation:

- amplitude, frequency and phase modulated carrier

- pulse and sine-wave AM waveforms
- "modulation index" as applied to a DSB AM waveform
- the production of single-sideband and double side-band AM signals
- the comparison of single and double sideband systems with specific reference to power and bandwidth
- the investigation of the operation of simple modulators, demodulators and detectors
- FM waveforms, frequency deviation and modulation index
- A comparison of AM with FM in relation to bandwidth (use of Carson's rule), power, and signal-to-noise ratio

b) **Digital Modulation:**

- transmitting an analogue signal as a series of pulses without loss of information
- the minimum sampling rate needed in order to accurately reconstruct an analogue signal
- PAM, PPM, PWM and PCM signal waveforms
- the process of analogue to PAM to PCM conversion
- the process of delta modulation
- compare delta modulation with PCM

c) **Digital Radio Modulation:**

- Digital Modulation techniques, BPSK, QPSK, QAM, $\pi/4$ DQPSK, MSK and GMSK
- choice of modulation technique in terms of quality, power, efficiency and bandwidth utilisation

3. RF Transmission Lines

- A description of RF transmission lines and their properties, as they apply to radio frequency transmission, will include;
- a uniform transmission line represented by a Pi or T-Network showing the primary constants
- the characteristic impedance (Zo) of a uniform transmission line
  - characteristic impedance expressed as the product of the open circuit and the short circuit impedances and calculated from the primary line constants
  - the secondary line coefficients
  - primary and secondary line constants as they relate to frequency
  - definition of the phase change constant (β) of a uniform transmission line
  - definition of phase velocity (v) of propagation of a wave along a line
  - "skin effect"

- the structure of a co-axial cable and the relationship of its dimensions to Zo and α
- the reasons for matching a transmission line to its load
- choosing a particular transmission line for a particular application
- measurement of maximum and minimum voltage values of a RF transmission line under various operating conditions

4. RF Propagation

➢ A description of the various propagation modes and an explanation of how they are affected by the ionosphere and terrestrial conditions will include;

- ground waves and sky waves
- the effect of refraction in the ionosphere
- skip distance, maximum useable frequency and optimum traffic frequency in non-mathematical terms
- the phenomenon of, and reasons for, fading
- the choice of transmission frequencies in the RF band
- the use of the various frequency band allocations (VLF- SHF)

5. Aerials

➢ A description of the construction of aerials and an explanation of their radiation patterns will include;

- concepts of radiation
- half wave dipole (opened out quarter wave open circuit line (equivalent)) and its electric and magnetic field patterns
- polarisation of an electromagnetic (em) wave and the pictorial representation of an em wave detaching from the local field
- frequencies necessary for efficient radiation
- induction and radiation fields
- transmitting and receiving aerials operating at given frequencies
- the Radiation Resistance of an aerial
- measurement of a half-wave dipole polar diagram with and without the addition of a reflector and director
- aerial gain in terms of an isotropic radiator
- effective radiated power
- the derivation of the Marconi unipole (from the dipole) and measurement of its polar diagram
- the effect of aerial height above ground (graphically illustrated)
- measurement of the forward and reverse power of an aerial feed as the aerial length is varied

6 Spread Spectrum techniques

- A description of the concept of Spread Spectrum and an explanation of the different techniques that are used will include;
    - frequency hopping and Direct Sequence Spread Spectrum
    - Code-Division Multiple Access (CDMA)
    - the use of pseudo noise sequences or orthogonal codes for generating spreading sequences

7 Error control

- An explanation of error detection and correction techniques used in mobile wireless applications will include;
    - parity check and cyclic redundancy check CRC
    - forward error correction (FEC), e.g. Hamming Code
    - automatic repeat request (ARQ)

8 Wireless LAN Infrared

- A description of Infrared transmission techniques, as applied to LAN's, will include;
    - limitations of Infrared (IR) transmissions
    - wavelengths, light sources and receivers
    - Omni-directional and Diffused systems

LEARNING RESOURCES

Required textbooks:

- Wireless Communications and Networks (2nd Edition) William Stallings. ISBN-13: 978-0130422323 (Published by Prentice Hall, January 10, 2002)