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:	2010
PRESCRIPTION EXPIRY DATE:	November 2013

Level and Assessment Schedule

TOPICS	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

The columns above under "Highest Skill Level" are R, C, A, P.

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)