Subject Description Form

Subject Code	EIE3331
Subject Title	Communication Fundamentals
Credit Value	3
Level	3
Pre-requisite	AMA2111 Mathematics I
Co-requisite/ Exclusion	Nil
Objectives	Telecommunication plays an important role in modern societies that rely heavily on a knowledge economy. Telecommunication systems enable the transfer and exchange of information over communication channels that are corrupted by disturbances and noises in a cost-effective manner. The major objectives of this subject are for the students to establish a firm foundation for the understanding of telecommunication systems, and the relationship among various technical and socio-economic factors when such systems are designed and operated.
Intended Subject Learning Outcomes	**Upon completion of the subject, students will be able to:** Category A: Professional/academic knowledge and skills 1. Identify various elements, processes, and parameters in telecommunication systems, and describe their functions, effects, and interrelationship. 2. Analyze, measure, and evaluate the performance of a telecommunication system against given criteria. 3. Design typical telecommunication systems that consist of basic and essential building blocks. Category B: Attributes for all-roundedness 4. Communicate effectively. 5. Think critically and creatively. 6. Assimilate new technological development in related field.
Subject Synopsis/ Indicative Syllabus	**Syllabus:** 1. Introduction (2 hour) 1.1 Introduction to telecommunication systems, their past and present development; elements of a basic communication system; examples of practical telecommunication systems. 2. Analog Communications (18 hours) 2.1 Amplitude Modulation (AM): double sideband, double sideband with suppressed carrier, single sideband, frequency spectrum and power of the AM signal, Frequency Division Multiplexing. 2.2 Demodulation of AM signals: coherent detector, direct demodulation 2.3 Frequency modulation: bandwidth of FM signals, Stereo FM. 2.4 Demodulation of FM signals: Phase-Locked Loop (PLL) detector. 2.5 Comparison of AM and FM performance: bandwidth, signal-to-noise ratio 3. Analog to Digital Conversion (4 hours) 3.1 Sampling theorem; pulse amplitude modulation 3.2 Quantizing: uniform quantization and quantization noise, SNR (e.g.: Audio CD standard), non-uniform quantization (e.g. A-law, u-law) 3.3 Pulse code modulation (PCM) 3.4 Time division multiplexing: T1 multiplexing system

4. Digital Modulation and Demodulation (9 hours)

4.1 ASK, FSK, PSK, DPSK, QPSK (e.g. satellite system), OQPSK, QAM (e.g. Microwave link applications), constellation diagram, bandwidth.
4.2 Coherent demodulation
4.3 Non-coherent demodulation (e.g. DPSK, OQPSK)
4.4 BER performance over Additive White Gaussian Noise (AWGN) channel
4.5 Effects of bandwidth, distortion, noise, timing error on detection, eye diagram

Practical:

- Matlab/Python simulation/experiments in communication systems (6 hours)

Teaching/ Learning Methodology

Teaching and Learning Method	**Intended Subject Learning Outcome**	**Remarks**
Lectures, supplemented with interactive questions and answers, and short quizzes	1,2,3,5,6	In lectures, students are introduced to the *knowledge* of the telecommunication field; *comprehension* of the knowledge is strengthened with interactive Q&A and short quizzes. The students will be able to *define* and *describe* key terms and concepts about telecommunication. They will also be able to *explain* and *generalize* knowledge about telecommunication (e.g. different modulation techniques and their performance, difference between analog and digital modulation techniques)
Tutorials where case studies are conducted, and problems are given to students for them to solve	1,2,3,4,5,6	In tutorials, students *apply* what they have learnt in analyzing cases (e.g. superheterodyne receiver structure) and solving problems (e.g. calculating the channel capacity of a given channel). They will *analyze* the given information, *compare* and *contrast* different scenarios and propose solutions or alternatives.
Lab, where students will conduct simulations/experiments on communication systems	2,3,4,5,6	By performing hands-on authentic tasks, the students will be able to *synthesize* a structure of knowledge by *designing* a solution to a communication problem. They will *relate* the observation to theories and principles. They will also *evaluate* outcomes of the tasks they perform and *interpret* the data they gather.

	Lab/ homework, quizzes, tests, end-of-chapter problems	1,2,3,4,5,6	Through working assignment and homework, online quizzes, and end-of-chapter problems in text books, students will develop a firm understanding and *comprehension* of the *knowledge* taught. They will *analyze* given information and *apply* knowledge in solving problems. For some design type of questions (e.g. design a communication link with a given S/N ratio), they will have to *synthesize* solutions by *evaluating* different alternatives.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific Assessment Methods/Tasks	**% Weighting**	**Intended Subject Learning Outcomes to be Assessed (Please tick as appropriate)**					
		1	**2**	**3**	**4**	**5**	**6**
1. Continuous Assessment (total 50%)							
• Lab assignment	10%		✓	✓	✓	✓	✓
• Quiz	20%	✓	✓	✓	✓	✓	
• Test	20%	✓	✓	✓	✓	✓	
2. Examination	50%	✓	✓	✓	✓	✓	
Total	100 %						

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Specific Assessment Methods/Tasks	Remark
Quizzes/ tests/examination	Quizzes, tests, and examinations are given to students to assess their competence level of *knowledge* and *comprehension*, ability to *analyze* given information, ability to *apply* knowledge and skills in new situation, ability to *synthesize* structure, and ability to evaluate given data to make judgment. The criteria (i.e. *what* to be demonstrated) and level (i.e. the *extent*) of achievement will be graded according to six levels: Excellent (A+ and A), Good (B+ and B), Satisfactory (C+ and C), Marginal (D) and Failure (F). These will be made known to the students. Feedback about their performance will be given promptly to students to help them improvement their learning.
Lab assignment	Students are required to conduct Matlab/Python simulations/experiments on communication systems. The emphasis is on assessing their ability to *apply* knowledge and skills learned in *designing*, *synthesizing* and ev*aluating* and ability to take data and relate the measurement results to theory. Specifically, the students will design and simulate practical communication signals/systems based on different modulation techniques and practical message signals.

		The ultimate goal is to deliver the student number of each student through a communication system. By comparing the different communication signals, the students are anticipated to gain an enhanced understanding of the fundamentals of communications. The performance will be evaluated based on a lab assignment report, Matlab/Python simulation codes, and the correctness of the communication system simulation. Feedback about their performance will be given promptly to students to help them improve their learning.

Student Study Effort Expected	**Class contact (time-tabled):**	
	• Lecture	24 Hours
	• Tutorial/Lab/Practice Classes	15 Hours
	Other student study effort:	
	• Lecture: preview/review of notes; homework/assignment; preparation for test/quizzes/examination	36 Hours
	• Tutorial/Lab/Practice Classes: preview of materials, revision and/or reports writing	30 Hours
	Total student study effort:	**105 Hours**
Reading List and References	**Reference Books:** 1. B. P. Lathi, Z. Ding, *Modern Digital and Analog Communication Systems*, 5th ed., Oxford University Press, 2019 2. H. Stern, S. A. Mahmoud, *Communication Systems: Analysis and Design*, Pearson, 2004 3. S. Haykin, *Communication Systems*, 4th ed., John Wiley, 2001 4. J. Proakis and M. Salehi, *Fundamentals of Communication Systems*, 2nd ed., Pearson, 2014	
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