Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIFTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
DECEMBER 2021-JANUARY 2022
SUBJECT: LINEAR CONTROL SYSTEM (ECE - 3152)

TIME: 85 Minutes **MAX. MARKS: 20**

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.
- Log and semi-log graph sheets will be provided on request.

Q. No.	Questions	M*	C*	A*	B*
1A.	If the received power at a reference distance d_0 = 1km is equal to 1 microwatt, find the received powers at distances of 2 km, 5 km, 10km, and 20km from the same transmitter for the following path loss models: [a] $\gamma = 3$ and [b] $\gamma = 4$	4	1	1,2 ,18	4
1B.	Assume a receiver is located 10 km from a 50 W transmitter. The carrier frequency is 900 MHz, free space propagation is assumed, G_t = 1, and Gr = 2, find [a] the power at the receiver in dBm [b] the rms voltage applied to the receiver input assuming that the receiver antenna impedance is 50 ohms.	3	1	1,2 ,18	4
1C.	With usual notations, develop an expression for cell coverage area in detail.	3	1	1,2 18	3
2A.	Consider a two-path channel with impulse response $h(t) = \alpha_1\delta(\tau) + \alpha_2\delta(\tau - 0.022\mu\text{sec})$. Find the distance separating the transmitter and receiver, as well as α_1 and α_2, assuming free space path loss on each path with a reflection coefficient of -1. Assume the transmitter and receiver are located 8 meters above the ground and the carrier frequency is 900 MHz.	4	2	1,3 ,18	4
2B.	[a] What is meant by a WSS process [b] Let $x(t) = a\cos(2\pi f_c t + \theta)$, where θ is uniformly distributed from $-\pi$ to π. Is x[t] a WSS process? [c] What is the power of the random process x[t].	4	2	1,2 ,18	5
2C.	Consider a communication system, with transmitter and receiver placed 10 m apart, is operating at 1 GHz and has a Time varying channel impulse response with N resolvable multipath components. Show that the minimum value of the product of carrier frequency and nth delay time is very much larger than unity. Is it true if the distance is changed to 1 m and 100 m?	2	2	1,3 ,18	5
3A	[a] For a Rayleigh channel, what is the probability that the attenuation of the channel is less than 20 dB. [b] What is the purpose of Nakagami channel. Describe the setting adopted in Nakagami channel to arrive at Rayleigh and Rician channel.	5	3	1,2 ,4, 17, 18	4
3B	Develop an expression for optimal power allocation and Shannon capacity of a block fading channel. Explain with all necessary diagrams.	3	4	1,2 ,18	3

3C	Assume a cellular system with BFSK modulation having both Rayleigh as well as log-normal shadow fading with Zero-mean Gaussian distributed random variable with variance of 81dB. Find average SNR per bit for a fixed path loss with averaging over these two fading that will ensure, for 85% of the time, the average error probability is $\leq 10^{-5}$. The desired maximum average error probability requires target SNR of 35dB.	2	3	1,2,4,17,18	4
4A	[a]Find Shannon capacity and power adaptation policy for a cellular system with an average transmitter power of 105mW, operating bandwidth of 9.7kHz and receiver noise PSD of 0.1mW. Let the receiver is at distance of d = 1100m and receiver power falloff with 'd' as $[P_t[d_o/d]^{1.1\alpha}]$ where $d_o = 100$m and α is a random variable taking the values 2, 2.5, 2.75, 3 and 3.25 with probabilities of 0.4, 0.3, 0.1, 0.1 and 0.1, respectively. [b] Find zero outage capacity.	4	3	1,2,17,18	5
4B	The scattering function for a fading channel is nonzero for the range $0 \leq \tau \leq 1$ ms and $-0.1 \leq \rho \leq 0.1$Hz. Find [a] Multipath spread [b] Doppler spread [c] Coherence time [d] Coherence bandwidth [e] Whether channel fading is frequency selective and why? [f] Whether channel signal is slowly fading and why?	3	3	1,2,17,18	4
4C	Comment on the Practical limitations related to the Implementation of Diversity schemes.	3	5	1,4,17,18	4
5A	Consider a wireless communication system operates only on QPSK modulation scheme. Find the outage probability for the given modulation at Ps = 10^{-3} for a Rayleigh fading channel with SC diversity for M = no diversity, M = 2, and M = 3. Assume branch SNRs γ_1 = 10 dB, γ_2 = 15 dB, and γ_3 = 20 dB. [Assume: Ps ≤ 10^{-3}, $\gamma_s \geq \gamma_0 = 10.8276$]. How to obtain the low-complexity equivalent of SC scheme and what could be the approximate outage probability. Give one practical application which suits this low complexity alternative.	4	5	1,4,17,18	5
5B	Explain the Alamouti scheme when no CSI is available at the Transmitter. Show that how Alamouti Scheme Achieves a diversity order of two for a 2×2 system.	3	5	1,4,17,18	4
5C	Why is an equalizer required? Explain the principle of working of decision feedback equalizer.	3	5	1,4,17,18	4

M*--Marks, C*--CLO, A*--AHEP LO, B* Blooms Taxonomy Level