

Birla Institute of Technology & Science, Pilani
Work Integrated Learning Program Division
First Semester 2022-2023

Mid-Semester Test
(EC-2 Regular)

Course No. : CSI ZG520
Course Title : Wireless and Mobile Communications
Nature of Exam : Open Book
Weightage : 30%
Duration : 2 Hours
Date of Exam : 25/09/2022 (FN)

No. of Pages	= 3
No. of Questions	= 6

Note to Students:

1. Please follow all the *Instructions to Candidates* given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. Assumptions made if any, should be stated clearly at the beginning of your answer.

Q. 1 A local spatial average of a power delay profile is shown in Fig. 1.

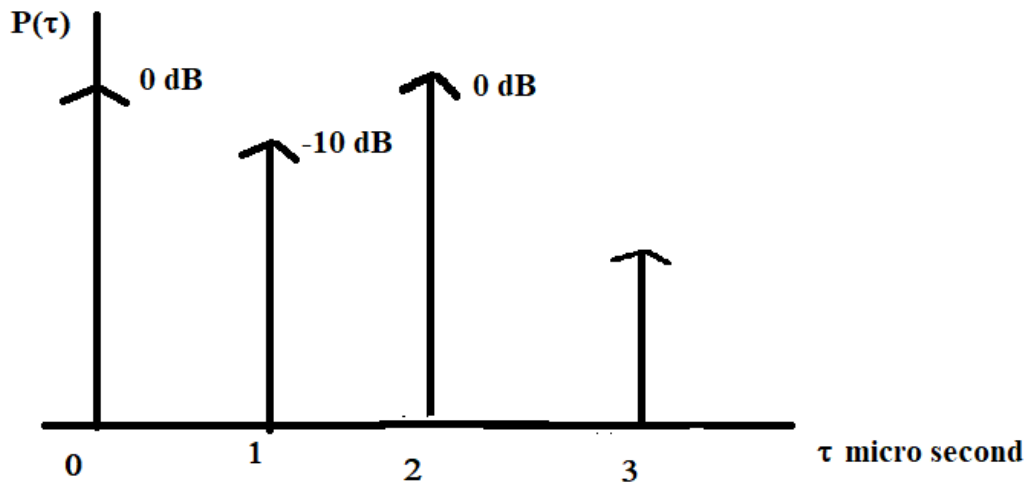


Fig. 1

Amplitude of an impulse function at $3\mu\text{s} = -20$ dB.

- (i) Determine the RMS delay spread and mean access delay for the channel. **4 marks**
- (ii) If the channel is to be used with a modulation that requires an equalizer whenever the symbol duration T is less than $10 \sigma_\tau$, determine the maximum RF symbol rate that can be supported without requiring an equalizer. **3 marks**
- (iii) If a mobile traveling at 30 km/hr receives a signal through the channel, determine the time over which the channel appears stationary (or at least highly correlated). **3 marks**

- Q. 2 (a) A vehicle moves with a velocity $v(t)$ as shown in Fig. 2. Determine the average crossing rate and fade duration over 100 seconds interval. Assume $\rho = 0.01$ and ignore large scale fading. **5 marks**
- (b) An application that requires a power outage probability of .01 for the threshold $P_o = -80$ dBm. For Rayleigh fading, determine the required average signal power? **2 marks**
- (c) A wireless system has data rate = 270 kbps and QPSK is used as a modulation scheme. Determine the maximum rms delay spread for which no equalizer is needed at the receiver. **3 marks**

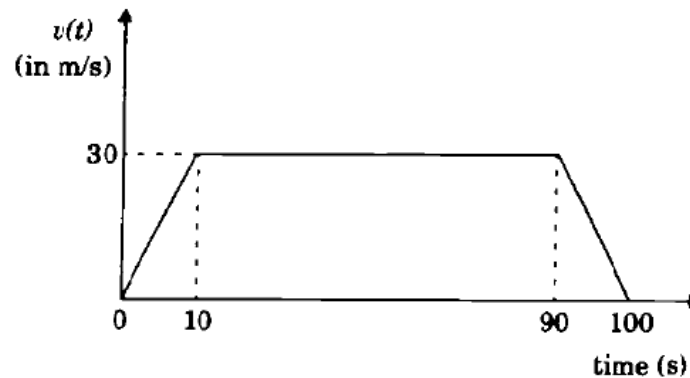


Fig. 2

- Q. 3 Consider an AM signal, **(5x2=10 marks)**

$$X(t) = 5 (1 + 0.7 \sin 2\pi f_m t) \cos 2\pi f_c t$$

$$f_m = 1 \text{ k Hz}, f_c = 200 \text{ k Hz}.$$
 - Determine the average sideband power for the given signal.
 - Determine the total power.
 - Determine bandwidth of the AM signal.
 - Determine the frequency of USB and LSB and plot the spectrum.
 - Determine power efficiency for the given signal.
- Q. 4 (a) In a GSM system, 8 channels can co-exist in 200 kHz bandwidth using TDMA. A GSM based cellular operator is allocated 10 MHz bandwidth. Assuming a frequency reuse factor of 0.2, i.e. a five-cell repeat pattern. Determine the maximum number of simultaneous channels that can exist in one cell. **3 marks**
- (b) A 36 MHz bandwidth limited transponder is allotted with voice only carrier in FDMA mode with 45 KHz separation between centre frequency of carriers. Assuming 40% voice activity, what will be the number of carriers? **4 marks**
- (c) The speed of an aircraft is 500 Km/hr and it is heading toward the airport control tower at an elevation of 25° . The communication between the tower and the plane takes place at a frequency of 128 MHz. Find the difference between the received frequencies at the aircraft receiver when it moves toward the airport and when it moves away from the airport. **3 marks**
- Q. 5 (a) Given the vehicular speed $v = 72$ km/hr, $f_c = 895$ MHz. Determine the coherence time and minimum symbol rate require to avoid frequency dispersion. **3 marks**

- (b) Assume a receiver is located a 10 km from a 50 W transmitter. The carrier frequency is 6 GHz and free space propagation is assumed, $G_r=1$, $G_t=1$. Find the power at the receiver.

3 marks

- (c) Show that the PDF given in eq (1) can be generated by Normal random variable.

$$P_R(r) = \frac{r}{\sigma^2} \exp\left(-\frac{r^2}{2\sigma^2}\right) \quad (1)$$

also find the percentage of time that a signal is 20 dB or more below the rms value for a Rayleigh fading signal.

4 marks

- Q. 6 (a) A continuous random variable X has probability density function

$$f_X(x) = \begin{cases} ce^{-x/2} & x \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

Find the probability $P[0 \leq X \leq 4]$, and $P[-2 \leq X \leq 2]$.

4 marks

- (b) A random process $W(t)$ is defined as

$$Z(t) = X_1 \cos(2\pi f_0 t) + X_2 \sin(2\pi f_0 t)$$

where X_1 and X_2 are uncorrelated random variables, haveig 0 mean and variance σ^2 . Find the autocorrelation function $R_z(t,\tau)$. Comment whether $Z(t)$ is WSS or not?

6 marks
