Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

M.TECH. (DEFENCE TECHNOLOGY) DEGREE END SEMESTER EXAMINATION (SECOND SEMESTER)

07-MAY-2024

SUBJECT: Fundamentals of Telemetry Telecommunication and Transponder (AAE - 5056)

TIME: 9:30-12:30 PM **MAX. MARKS: 50**

Instructions to candidates
- Answer **ALL** questions.
- Missing data may be suitably assumed.

Q. No.	Questions	MARKS*
1A.	How does the integration of Tracking, Telemetry, and Command (TT&C) systems facilitate precise control and monitoring of satellites in orbit? What are the key challenges in ensuring seamless communication and data exchange between ground stations and satellites?	**5**
1B.	Derive the equation for different sampling intervals using the first principles of trigonometric Fourier series, then create a strategy to reduce the effect of aliasing on a received signal.	**5**
2A.	Mention the factors contribute to ground station localization errors when communicating with satellites, and design what strategies can be implemented to minimize these errors and optimize communication reliability using RF and FSO or hybrid scheme?	**5**
2B.	Consider an earth station located in Udupi DK, and a GSO satellite located at $97^0 W$. It is assumed that the input parameters are using the sign conventions: **Earth Station: Udupi, DC:** Latitude: LE =13.3^0 N=+13, Longitude: lE =74^0 E=+74.74, Altitude: $H = 0\, km$. **Satellite**: Latitude: LS =0^0 (inclination angle=0), Longitude: lS =65^0 S=65 **Find the range, d, the elevation angle, and the azimuth angle, Z, to the satellite.** Comment on the results.	**5**
3A.	Consider the transmitting antenna of a geostationary satellite fed with a power P_T of 10W, at a frequency f_D = 12 GHz, and radiating this power in a beam of width θ_{3dB} equal to 2^0. An earth station equipped with a 4m diameter antenna is located on the axis at a distance of 40,000km from the satellite. The efficiency of the satellite antenna is assumed to be η = 0.55 and that of the earth station to be η = 0.6. Find the received power.	**5**

3B.	Under certain atmospheric conditions, a 2 GHz linearly polarized signal experiences a rotation on its plane of polarization by 75^0. How much polarization rotation would have been experienced by a 10 GHz signal under similar conditions? Further, determine the attenuation in (dB) experienced by the copolar component due to polarization rotation if it is not corrected at the receiver end. Give a physical insight on increasing the frequency of operation.	**5**
4A.	Illustrate the operational mechanism of a standard MIMO imaging based LADAR system featuring a 3D laser. With the help of a block diagram explain how imaging optics plays a crucial role in identification of the target.	**5**
4B.	Critically comment on how Interference is reduced in a CDMA system. Describe the procedure of how pseudorandom code sequence helps in reducing the ISI.	**5**
5A.	How does the Automatic Navigation architecture facilitate the estimation of signals exchanged between Unmanned Aerial Vehicles (UAVs) and ground stations, and mention the significance of the estimator used with the help of block diagram?	**5**
5B.	Propose a comprehensive scheme for employing a 3D flash imaging (Doppler and Electro optic methods of tracking) to survey a terrain area located in a hilly region. Consider factors such as the acquisition of data, processing methodologies, and the integration of terrain variability into the imaging process. Write the block diagram to support your claims.	**5**

FORMULAE:

$$B = 1E - 1S$$

$$z = \left(\frac{r_e \left(1 - e_e^2\right)}{\sqrt{1 - e_e^2 \sin^2(L_E)}} + H \right) \sin(L_E)$$

$$l = \left(\frac{r_e}{\sqrt{1 - e_e^2 \sin^2(L_E)}} + H \right) \cos(L_E)$$

$$\Psi_E = \tan^{-1}\left(\frac{z}{l}\right)$$

$$R = \sqrt{l^2 + z^2}$$

$$d = \sqrt{R^2 + {r_s}^2 - 2\, R\, r_s \cos(\Psi_E) \cos(B)}$$

$$\theta = \cos^{-1}\left(\frac{r_e + h_{GSO}}{d} \sqrt{1 - \cos^2(B) \cos^2(L_e)} \right)$$

$$\beta = \cos^{-1}\left[\cos(B) \cos(L_E)\right]$$

$$A_i = \sin^{-1}\left(\frac{\sin(|B|)}{\sin(\beta)} \right)$$