Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

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SECOND SEMESTER M.TECH. (AVIONICS)

END SEMESTER EXAMINATIONS, APRIL 2024

AIRBORNE PLATFORM SYSTEM DESIGN APPROACH-SMALL SATELLITE DESIGN [AAE 5216]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 30 April 2024** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

Q.NO	Questions	Marks	CO	BTL
1A.	Sketch a neat diagram of typical tracking, telemetry command and monitoring system and explain it.	*(03)*	*CO3*	*L2*
1B.	Justify the future trend of small satellite and Unmanned Aircraft systems.	*(03)*	*CO6*	*L5*
1C.	With neat block diagram, discuss the interface and functionalities of onboard computer (OBC) in small satellite.	*(04)*	*CO3*	*L2*
2A.	Design a double conversion transponder for 14/11 GHz. Sketch neat diagram and explain their components.	*(05)*	*CO3*	*L6*
2B.	Briefly formulate the system engineering aspects of power and RF system for a small satellite.	*(05)*	*CO5*	*L6*
3A.	Analyze the space environment, its effects and facilities required to test the small satellite.	*(04)*	*CO4*	*L4*
3B.	What is miniaturization approach of small satellite & facilities required?	*(03)*	*CO4*	*L3*
3C.	List the software and hardware tools required for spacecraft mission.	*(03)*	*CO6*	*L2*
4A.	What is spacecraft system engineering? Discuss the system engineering and system management in the design, development & deployment of small satellites.	*(05)*	*CO2*	*L3*

4B. With neat diagrams, do the noise analysis and derive the system noise temperature in a double superhet configuration receiver. ***(05) CO3 L2***

5A. List the factors influencing the position accuracy in satellite. ***(02) CO3 L2***

Design Problem for 5B: Parameters to design a communication link through a geostationary satellite to meet a C/N and link margin specification.

Use these constants:
Boltzmann's constant k = -228.6 dBW/K/Hz

Path length to satellite = 38,500 km

Satellite :
Geostationary at 73 deg W longitude.
24 C band transponders, 28 Ku band transponders
3.2 kW RF power output

Antenna gain, on axis, C-band and Ku-band (transmit and receive) = 31 dB
Receive system noise temperature (C-band and Ku-band) = 500 K
Transponder saturated output power: C-band = 40 W

Transponder bandwidth: C-band = 36 MHz

Transponder saturated output power: Ku-band = 80 W
Transponder bandwidth: Ku-band = 54 MHz

Signals:

FM-TV analog signal to be received in a bandwidth of 27 MHz.
Multiplexed digital TV signals transmitted as QPSK with symbol rate 27 Msps using half rate FEC with coding gain 5.5 dB

Minimum permitted C/N overall = 9.5 dB

5B. Design a Ku-band receiving earth station to provide an overall clear air C/N of 17 dB in a 27 MHz IF noise bandwidth at a carrier frequency of 11.45 GHz. The antenna noise temperature is 30 K and the LNA noise temperature is 110 K. ***(08) CO3 L6***

You may assume a high gain LNA and ignore the noise generated in other parts of the receiver.

A. Discuss the link budget.
B. Determine the diameter of the receiving antenna. The receiving terminal is located on the 3 dB contour of the satellite footprint, and clear air attenuation on the path and other losses total 0.8 dB.