	St. Francis Institute of Technology (Engg. College) **Internal Assessment Test-I** Academic Year: 2023-2024
Branch: INFT Division: A & B	Year: S.E. Semester: III
Subject: Principle of Communication	Time: 3:00 pm - 4:00 pm
Date: 17/08/2023	No. of Pages: 01
Marks: 20 Marks	

Instructions: Candidates should read carefully the instructions printed on the question paper and on the cover of the Answer Book, which is provided for their use.

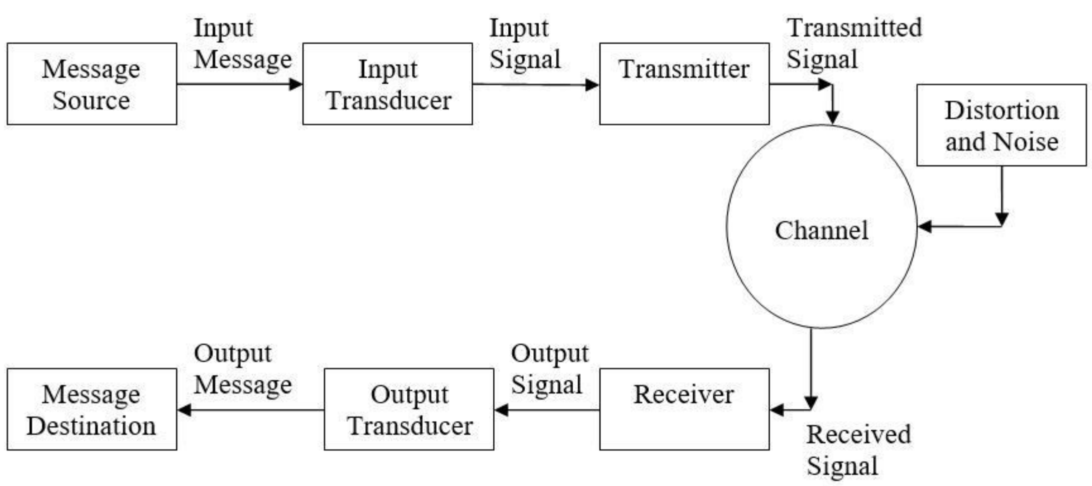
Note the following instructions.

1. All questions are compulsory.
2. Draw neat diagrams wherever necessary.
3. Write everything in ink (no pencil) only.
4. Assume data, if missing, with justification.

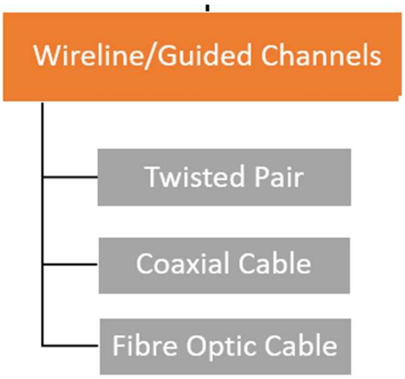
SOLUTION

Q 1.	Attempt any five.	Marks
a.	Give one example of each – simplex mode of communication, full duplex mode of communication. Simplex mode of communication – Radio, Television broadcasting Full duplex mode of communication – Telephones	2
b.	Point out an application in the given frequency band – VHF, UHF. VHF- FM Radio, TV broadcasting UHF – TV broadcasting, Cellular phones	2
c.	State advantages and limitations of digital communication over analog communication. (Any 2) **Advantages of Digital Communication Systems** • Hardware design and implementation of digital circuits more flexible, easy and cheaper than analog circuits • Occurrence of cross-talk is very rare in digital communication • Regenerative repeaters can be used at fixed distance along the link to identify and regenerate a pulse before it degrades to an ambiguous state • Digital signals less affected by distortion, noise, and interference • Signal processing functions such as encryption and compression employed to maintain the secrecy of the information and efficiency of the system • *Probability of error* reduced by employing error detecting and error correcting codes. Hence, digital circuits are more reliable • Spread spectrum technique can be used to avoid signal jamming • Combining digital signals using TDM is easier than combining analog signals using FDM • Digital signals can be saved and retrieved more conveniently than analog signals • Many of the digital circuits have almost common encoding techniques and hence similar devices can be used for a number of purposes	2

	Limitations of Digital Communication Systems • Quantization or sampling error occurs while conversion of signal from analog to discrete • Needs synchronization • Requires more bandwidth as compared to analog systems	
d.	Solve – (i) For an amplifier with output signal of 10W and output noise power of 0.01 W, determine signal to noise ratio in dB. (ii) For a bandwidth of 150 kHz, calculate thermal noise voltage generated by a resistor of 30 kohms, given the ambient temperature is 17 degree centigrade. (i) $\frac{S}{N} = 10log_{10}\frac{P_s}{P_n} = 10log_{10}\frac{10}{0.01} = 30dB$ (ii) Temp in °K = 17 + 273 = 290 °K $V_n = \sqrt{4KTBR} = \sqrt{4x1.38x10^8x290x150x10^3x30x10^3} = 8.48\ \mu V$	2
e.	State and prove the time shifting property of Fourier Transform. → TIME SHIFTING – The time shifting property states that if $x(t)$ and $X(f)$ form a Fourier transform pair, then – $\underbrace{x(t-t_d)}_{\text{Time shifted signal}} \xleftrightarrow{F} e^{-j2\pi f t_d} \cdot X(f)$ Proof – We know – $F[x(t)] = X(f) = \int_{-\infty}^{\infty} x(t) \cdot e^{-j2\pi f t} \cdot dt$ $\therefore F[x(t-t_d)] = \int_{-\infty}^{\infty} x(t-t_d) \cdot e^{-j2\pi f t} \cdot dt$ Let, $(t-t_d) = \tau$ $\Rightarrow t = \tau + t_d \quad \Rightarrow dt = d\tau$ $\therefore F[x(t-t_d)] = \int^{\infty} x(\tau) \cdot e^{-j2\pi f(\tau+t_d)} \cdot d\tau$	2

	$\therefore F[x(t-t_d)] = \int_{-\infty}^{\infty} x(\tau) \cdot e^{-j}$ $= \int_{-\infty}^{\infty} x(\tau) \cdot e^{-j2\pi f\tau} \cdot e$ $= e^{-j2\pi f t_d} \int_{-\infty}^{\infty} x(\tau) \cdot e^{-}$	
f.	Infer the type of internal noise which is caused due to – (i) Random fluctuations in division of current (ii) Rapid and random movement of free electrons within a conductor due to thermal agitation. (i) Random fluctuations in division of current – Partition Noise (ii) Rapid and random movement of free electrons within a conductor due to thermal agitation – Thermal Noise	2
Q 2.	**Attempt any one.**	
a.	Illustrate block diagram of an analog communication system and explain each block. 	5

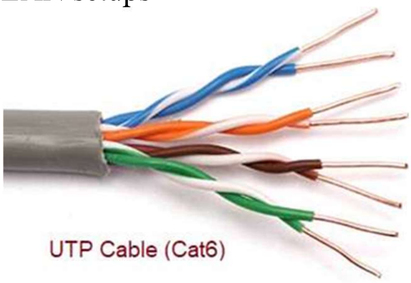
b. Explain types of wired communication channels. 5

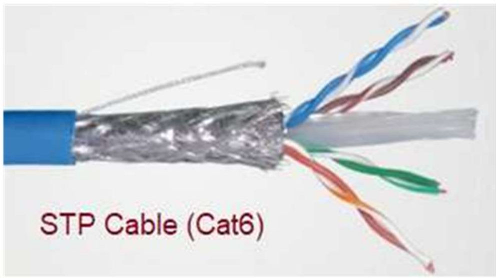


Twisted Pair

UTP - Consists of two insulated Cu wires twisted to reduce interference
Uses – Home telephones, Intercoms

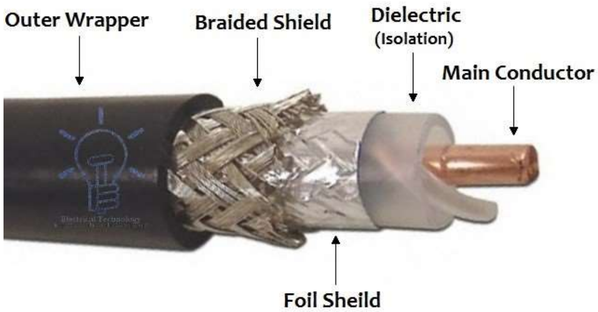
STP - Consists of two insulated Cu wires twisted and enclosed in a shield for better interference reduction
Uses – LAN setups





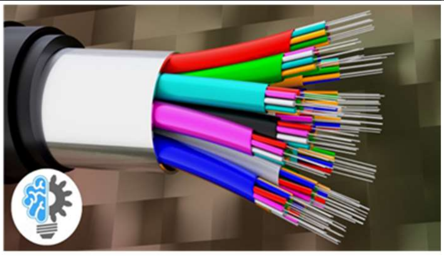
Coaxial Cable

Consists of a single Cu conductor at its centre. Has layers of insulation to reduce interference
Uses – For long distance communication like cable TV, high speed LAN cabling, CCTV

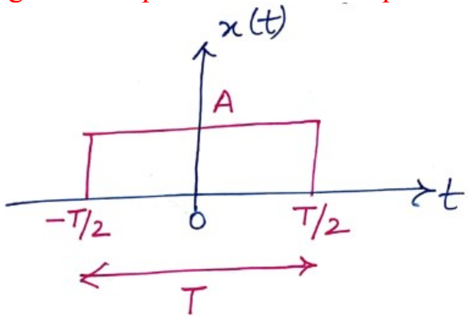


Optical Fibre Cable

Consists of a glass core that carries light signal, works on principle of TIR, supports very high BW, attenuation very less, so used for very long-distance communication
Uses –High speed internet connectivity for real time, interactive multimedia applications

	 	
Q 3.	**Attempt any one.**	
a.	Determine Fourier Transform of gate signal of amplitude A and time period T.	5

$$x(t) = A \; ; -\frac{T}{2} \leq t \leq \frac{T}{2}$$
$$= 0 \; ; \text{ otherwise}$$



Soln: We know —

$$F[x(t)] = \int_{-\infty}^{\infty} x(t) \cdot e^{-j2\pi ft} \cdot dt$$

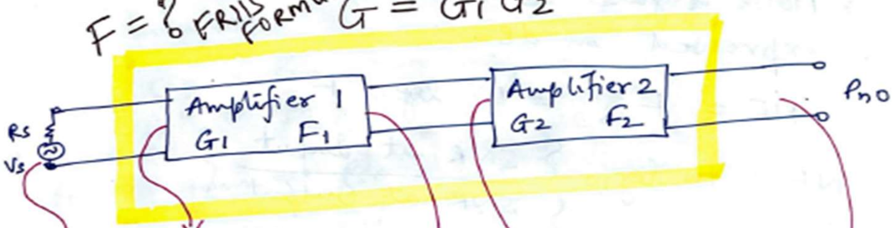
$$= \int_{-T/2}^{T/2} A \cdot e^{-j2\pi ft} \cdot dt$$

$$= \frac{A}{-j2\pi f} \left[e^{-j2\pi ft} \right]_{-T/2}^{T/2}$$

$$= \frac{-A}{j2\pi f} \left[e^{-j\cancel{2}\pi f \frac{T}{\cancel{2}}} - e^{j\cancel{2}\pi f \frac{T}{\cancel{2}}} \right]$$

$$= \frac{-A}{j2\pi f} \left[e^{-j\pi f T} - e^{j\pi f T} \right]$$

$$= \frac{A}{j2\pi f} \left[e^{j\overset{\theta}{\pi f T}} - e^{-j\pi f T} \right]$$

	$= \frac{A}{\pi f}\left[\frac{e^{j\pi f T} - e^{-j\pi f T}}{2j}\right]$ ($\pi f T \to \theta$) According to Euler's theorem – $\sin\theta = \frac{e^{j\theta} - e^{-j\theta}}{2j}$ $\therefore F[x(t)] = \frac{A}{\pi f}\left[\sin(\pi f T)\right]$ $= \frac{AT}{\pi f T}\left[\sin(\pi f T)\right]$ $= AT\left[\frac{\sin(\pi f T)}{\pi f T}\right]$ ($\pi f T \to \theta$) We know – $\operatorname{sinc}\theta = \frac{\sin\theta}{\theta}$ $\boxed{\therefore F[x(t)] = AT \operatorname{sinc}(\pi f T)}$	
b.	Derive the expression for Friis formula for cascaded amplifiers. → Noise factor of Amplifiers in Cascade – $F = ?$ FRIIS FORMULA $G = G_1 G_2$  $\underbrace{KTB + (F_1 - 1)KTB}$ $P_{ni\,total} = F_1 KTB$ $\underbrace{G_1 F_1 KTB + (F_2 - 1)KTB}$ $G_2\left[G_1 F_1 KTB + (F_2 - 1)KTB\right]$ $= G_1 G_2 F_1 KTB + G_2(F_2 - 1)KTB$	5

→ Noise due to source, $P_{nsource} = KTB$

Noise due to Amplifier 1, $= (F_1 - 1) KTB$

∴ Total noise at input of Amplifier 1,

$$P_{nitotal} = KTB + (F_1 - 1) KTB = F_1 KTB$$

→ ∴ Noise at output of Amplifier 1 is –

$$= G_1 (F_1 KTB) = F_1 G_1 KTB$$

→ Noise due to Amplifier 2,

$$= (F_2 - 1) KTB$$

→ ∴ Total noise at input of Amplifier 2,

$$= F_1 G_1 KTB + (F_2 - 1) KTB$$

→ ∴ Noise at output of Amplifier 2, P_{no}

$$P_{no} = G_2 \{ F_1 G_1 KTB + (F_2 - 1) KTB \}$$

$$P_{no} = G_1 G_2 F_1 KTB + G_2 (F_2 - 1) KTB \quad \text{——— (A)}$$

→ Now,

Overall gain $= G = G_1 G_2$

$$\text{Overall } F = \frac{P_{no}}{G P_{ni}} \qquad [\because P_{no} = F G P_{ni}]$$

$$= \frac{P_{no}}{G_1 G_2 KTB} \qquad \left[\because P_{ni} = P_{source} = KTB\right]$$

From (A),

$$\therefore F = \frac{G_1 G_2 F_1 KTB + G_2 (F_2 - 1) KTB}{G_1 G_2 KTB}$$

	$\Rightarrow \boxed{F = F_1 + \frac{(F_2 - 1)}{G_1}}$ FRIIS FORMULA We can extend this as – $F = F_1 + \frac{(F_2 - 1)}{G_1} + \frac{(F_3 - 1)}{G_1 G_2} + \ldots$	