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**Sample Question Paper for
Ph.D. (Electronics & Communication Engineering)
SPSAT'18**

INSTRUCTIONS

The test is 60 minutes long and consists of 40 multiple choice questions (MCQ) adding up to 40 marks.

1. The capacity of a band-limited additive white Gaussian noise (AWGN) channel is given by $C = W \log_2 \left(1 + \frac{P}{\sigma^2 W} \right)$ bits per second (bps), where W is the channel bandwidth, P is the average power received and σ^2 is the one-sided power spectral density of the AWGN. For a fixed $\frac{P}{\sigma^2 W} = 1000$, the channel capacity (in kbps) with infinite bandwidth W is approximately
(a) 1.44 (b) 1.08 (c) 0.72 (d) 0.36
2. Consider sinusoidal modulation in an AM system. Assuming no over modulation, the modulation index (μ) when the maximum and minimum values of the envelope, respectively, are 3 V and 1 V, is
(a) 1.0 (b) 0.5 (c) 0.75 (d) 0.25
3. The capacity of a Binary Symmetric Channel (BSC) with cross-over probability 0.5 is _____
(a) 0 (b) 0.5 (c) 0.2 (d) 0.25
4. An analog voltage in the range 0 to 8 V is divided in 16 equal intervals for conversion to 4-bit digital output. The maximum quantization error (in V) is
(a) 1.0 (b) 0.5 (c) 0.75 (d) 0.25
5. Let $x(t) = \cos(10\pi t) + \cos(30\pi t)$ be sampled at 20 Hz and reconstructed using an ideal low pass filter with cut-off frequency of 20 Hz. The frequency/frequencies present in the reconstructed signal is/are
(a) 5 Hz & 15 Hz only (b) 10 Hz & 15 Hz only
(c) 5 Hz, 10 Hz & 15 Hz only (d) 5 Hz only
6. A modulated signal is $y(t) = m(t) \cdot \cos(40000 \pi t)$, where the baseband signal $m(t)$ has frequency components less than 5 kHz only. The minimum required rate (in kHz) at which $y(t)$ should be sampled to recover $m(t)$ is
(a) 5 KHz only (b) 10 KHz only (c) 15 KHz only (d) 10 Hz only

7. The phase response of a passband waveform at the receiver is given by: $\phi(f) = -2\pi\alpha\beta f_c(f - f_c) - 2\pi\beta f_c$. Where f_c is the centre frequency, and α and β are positive constants. The actual signal propagation delay from the transmitter to receiver is
- (a) $\frac{\alpha-\beta}{\alpha+\beta}$ (b) $\frac{\alpha\beta}{\alpha+\beta}$ (c) α (d) β
8. Consider two real valued signals, $x(t)$ band-limited to $[-500 \text{ Hz}, 500\text{Hz}]$ and $y(t)$ band limited to $[-1\text{kHz}, 1\text{kHz}]$. For $z(t) = x(t) \cdot y(t)$, find the Nyquist sampling frequency (in kHz).
- (a) 5 KHz (b) 3 KHz (c) 15 KHz (d) 10 KHz
9. In a PCM system, the signal $m(t) = \{\sin(100\pi t) + \cos(100\pi t)\}$ V is sampled at the Nyquist rate. The samples are processed by a uniform quantizer with step size 0.75 V, the minimum data rate of the PCM system in bits per second.
- (a) 500 bits/second (b) 300 bits/second (c) 200 bits/second (d) 100 bits/second
10. The bit rate of a digital communication system is R kbits/s. The modulation used is 32-QAM. The minimum bandwidth required for ISI free transmission is
- (a) $\frac{R}{10}$ (b) $\frac{R}{5}$ (c) R (d) $\frac{R}{15}$
11. For a periodic signal $v(t) = 30\sin 100t + 10\cos 300t + 6\sin(500t + \pi/4)$, the fundamental frequency in rad/s
- (a) 500 rad/sec (b) 300 rad/sec (c) 200 rad/sec (d) 100 rad/sec
12. Consider an FM signal $f(t) = \cos(2\pi f_c t + \beta_1 \sin 2\pi f_1 t + \beta_2 \sin 2\pi f_2 t)$. The maximum deviation of the instantaneous frequency from the carrier frequency f_c is
- (a) $\beta_1 f_1 + \beta_2 f_2$ (b) $\beta_1 f_2 + \beta_2 f_1$ (c) $\beta_1 + \beta_2$ (d) $f_1 + f_2$
13. In a double side-band (DSB) full carrier AM transmission system, if the modulation index is doubled, then the ratio of total sideband power to the carrier power increases by a factor of
- (a) 4 (b) 2 (c) 3 (d) 5
14. The Column – 1 lists the attributes and the Column – 2 lists the modulation systems. Match the attribute to the modulation system that best meets it.

Column – 1	Column – 2
P. Power efficient transmission of signals	I. Conventional AM
Q. Most bandwidth efficient transmission of voice signals	II. FM
R. Simplest receiver structure	III. VSB
S. Bandwidth efficient transmission of signals with significant component	IV. SSB - SC

- (a) P – IV, Q – II, R – I, S – III (b) P – II, Q – IV, R – I, S – III
- (c) P – III, Q – II, R – I, S – IV (d) P – II, Q – IV, R – III, S – I

15. A message signal is $m(t) = \cos(20000 \pi t) + 4 \cos(40000 \pi t)$ modulates the carrier $c(t) = \cos(2\pi f_c t)$ where $f_c = 1\text{MHz}$ to produce an AM signal. For demodulating the generated AM signal using an envelope detector, the time constant RC of the detector circuit should satisfy
- (a) $0.5 \text{ ms} < RC < 1 \text{ ms}$ (b) $1 \mu\text{s} \ll RC < 0.5 \text{ ms}$
(c) $RC \ll 1 \mu\text{s}$ (d) $RC \gg 0.5 \text{ ms}$
16. In a 555 astable-multivibrator operating from V_{cc} of 15V, the output wave from duty cycle is 0.4 (duty cycle = ON-time/total time period.) the circuit is slightly modified with the capacitor now charging from a voltage of 30V rather than V_{cc} . the duty cycle of the output waveform in the modified circuit will
- (a) Remain unchanged (b) Become about 0.6
(c) Be approximately 0.2 (d) None of the above
17. In half wave SCR power control circuit, if the firing angle is 300° , then for one complete cycle of operation, the load gets power for
- (a) 600 (b) 1500 (c) 3300 (d) 300
18. A feedback control system has a transfer function given by:

$$P(s) = \frac{(s+1)(s+3)}{s(s+2)(s+4)}$$
It's a
- (a) Type-5 system (b) Type -2 system (c) Type-3 system (d) Type-4 system
19. For drawing the root locus plot of a certain closed loop control system, one needs to know
- (a) Only the open loop transfer function of the system
(b) The closed loop transfer function (c) The closed loop system pole-zero maps
(d) The open loop transfer function, gain and phase margins
20. An electromagnetic wave in which the electric field is entirely transverse to the direction of propagation is known as
- (a) TE wave (b) TEM wave (c) TM wave (d) TE₁₀ wave
(e) TE₁₁ wave
21. During night- time the ionosphere consists of:
- (a) D,E,F₁,F₂ layers (b) D,E,F₁, layers (c) E,F₁,F₂ layers (d) E & F₂ layers.
22. An antenna is radiating 100 watts and is drawing 2A from the transmitter, its radiation resistance is:
- (a) 100 W (b) 50 W (c) 25W (d) None of the above
23. The impedance curve of an R-L-C network cuts the frequency axis only when the frequency is such that
- (a) $X_L = X_C$ (b) $X_L = X_C = 0$ (c) $R=0$ & $X_L = X_C$ (d) None of the above

24. Indicate the false statement
- (a) Closed loop gain is always less than the open loop gain
 - (b) Input impedance is always greater than the output impedance
 - (c) The open loop gain falls to zero decibel at a frequency equal to unity gain crossover frequency
 - (d) Closed loop bandwidth is always greater than the open loop bandwidth.
25. The SLEW RATE specification of an operational amplifier is usually measured in
- (a) Microvolts per second
 - (b) Volts per microsecond
 - (c) Decibels
 - (d) Volts per microvolt
26. A given operational amplifier has an open loop gain of 110dB and a CMRR rating of 106dB. What should be the open loop common mode gain of this op-amp?
- (a) It cannot be determined from the given data
 - (b) 4 dB
 - (c) 216 dB
 - (d) 110 dB
27. When a PLL is being used as an FM demodulator, the demodulated signal appears at
- (a) The output of phase comparator
 - (b) the output of low pass filter
 - (c) The VCO output
 - (d) None of the above
28. For one of the following conditions, clocked j-k flip flop can be used as DIVIDE BY 2 circuit where the pulse train to be divided is applied at clock input.
- (a) $J=1, K=1$ and the flip flop should have active HIGH inputs
 - (b) $J=1, K=1$ and the flip flop should have active LOW inputs
 - (c) $J=0, K=0$ and the flip flop should have active high inputs
 - (d) $J=1, K=1$ and the flip flop should be a negative edge triggered one
29. In a preset table, clearable positive edge triggered J-K flip flop, the Q output when the flip flop is clocked for $J=1, K=0, \text{preset}=1$ and $\text{clear} = 0$ will be
- (a) 1
 - (b) 0
 - (c) Indeterminate
 - (d) Complement of what it was at the time of clocking
- (Assume all the inputs to be active LOW inputs)
30. A 4-bit circulating register is initially set to 0001 (1 is the true output of the first flip flop and represents LSB). 4-bit number preset in the register at the end of 16 clock pulses is
- (a) 0001
 - (b) 0010
 - (c) 0100
 - (d) 1000
31. A 4-bit R/2R digital-to-analog (DAC) converter has a reference of 5 volts. What is the analog output for the input code 0101.
- (a) 0.3125 V
 - (b) 3.125 V
 - (c) 0.78125 V
 - (d) -3.125 V
32. Lower the thermal resistances (junction-to-case-to-ambient) of a bipolar transistor,

- (a) lower is the power dissipation capability for a given ambient temperature
 - (b) higher is the power dissipation capability for a given ambient temperature
 - (c) higher is the probability of the device going to thermal runaway
 - (d) better is its high frequency performance
33. The dominant mode in rectangular waveguides is the
- (a) TE₁₀ mode
 - (b) TM₀₁ mode
 - (c) TE₁₁ mode
 - (d) TM₁₁ mode
34. If the received carrier frequency in an AM communications broadcast receiver is changed from 560 kHz to 1120 kHz the resonant frequency of the IF tuned circuits
- (a) Would have to be changed from 455Khz to 910khz.
 - (b) Would remain unchanged at 455khz
 - (c) Would also change in the same proportion but in the opposite direction
 - (d) None of the above
35. A shift counter comprising of 5 flip flops with an inverse feedback from the output of the MSB flip flop to the input of the LSB flip flop is a
- (a) Divide by 32 counter
 - (b) Divide by 10 counter
 - (c) 5-bit shift register
 - (d) Modulus-5 counter
36. Number of comparators needed to build a 6-bit simultaneous A/D converter is
- (a) 63
 - (b) 64
 - (c) 7
 - (d) 6
37. By increasing the height of the TV receiving antenna:
- (a) The range of TV broadcast decreases
 - (b) Signal pick up is less
 - (c) Antenna may fail to receive the signal
 - (d) The range of TV broadcast increases
 - (e) None of the above
38. In electromagnetic waves, polarization is:
- (a) Due to transverse nature of waves
 - (b) always vertical in isotropic medium
 - (c) Due to longitudinal nature of waves
 - (d) caused by reflection of waves
39. What is the RST for the TRAP?
- (a) RST5.5
 - (b) RST4.5
 - (c) RST4
 - (d) None of the above
40. When the 8051 is reset and the EA line is high, the program counter points to the first program instruction in the
- (a) Internal code memory
 - (b) External code memory
 - (c) Internal data memory
 - (d) External data memory