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Prelims Through Questions

for

ESE 2021

Electrical Engineering

Day 11 of 11

Q.451 - Q.500

(Out of 500 Questions)

Electrical Materials + Computer Fundamentals + Communication Systems

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Q.451 The dielectric material of strength 20 kV/mm used in a capacitor is 8 cm in width, 14 cm in length and 0.04 mm in thickness. If the capacitor with such dielectric material is subjected to increasing voltage, then breakdown of dielectric occurs at

(a) 0.4 kV (b) 8.0 kV
(c) 4.0 kV (d) 0.8 kV

451. (d)

The thickness of material, $d = 0.04$ mm

Dielectric strength, $E = 20\,\text{kV/mm}$

So, $V = E.d$

$= 20 \times 10^3 \times 0.04 = 800$ V or 0.8 kV

Q.452 Consider the following statements regarding 'Polarization' phenomenon occurring in dielectric materials.

1. Electronic polarization occurs when centroids of electronic cloud and nucleus in an atom are separated under influence of external electric field.
2. In some dielectric materials dipoles exist in the molecular structure of materials even when external field is not applied.
3. Relative permittivity $\in_r$ of a material does not depends upon orientation of the dipoles with respect to applied field direction.

Which of the above statements is/are **not** correct?

(a) 1 and 2 only (b) 2 only
(c) 2 and 3 only (d) 3 only

452. (d)

Relative permittivity $\in_r$ is dependent on orientation of dipoles in dielectric with respect to applied field direction.

Q.453 Consider the following statements regarding ferroelectric materials.

1. Ferroelectric materials are special dielectric materials that consists of crystals that are spontaneously polarized.
2. Piezoelectric effect is shown by all ferroelectric materials.
3. Quartz crystal is an example of ferroelectric materials.

Which of the above statement(s) is/are correct?

(a) 1 only (b) 2 and 3 only
(c) 1 and 2 only (d) 1, 2 and 3

453. (c)

Quartz crystal is piezoelectric but not ferroelectric material.

Q.454 The crystal structure of an element is face centered cubic with cube side length 'a'. The atomic packing fraction and radius of atom in terms of cube side will be respectively.

(a) $\frac{\pi}{3\sqrt{3}}, \frac{a}{2\sqrt{2}}$ (b) $\frac{\pi}{3\sqrt{2}}, \frac{a}{2\sqrt{3}}$

(c) $\frac{\pi}{3\sqrt{2}}, \frac{a}{2\sqrt{2}}$ (d) $\frac{\pi}{3\sqrt{3}}, \frac{a}{2\sqrt{3}}$

454. (c)

Atomic packing fraction for face centre cubic structure : $\frac{4 \times \text{Volume of atom}}{\text{Volume of cube}}$

For face centered cube

No. of atoms per unit cell:

$$\frac{1}{8} \times 8 + 6 \times \frac{1}{2} = 4$$

For face centered cubic system,

$$4r = a\sqrt{2}$$

Where r is atomic radius and a is cube side length

$$r = \frac{a\sqrt{2}}{4} = \frac{a}{2\sqrt{2}}$$

$$\therefore \text{ Atomic packing fraction } = \frac{4 \times \frac{4}{3}\pi\left(\frac{a}{2\sqrt{2}}\right)^3}{a^3} = 4 \times \frac{4}{3}\pi \times \frac{a^3}{8 \times 2\sqrt{2}\, a^3} = \frac{\pi}{3\sqrt{2}}$$

Q.455 Consider the following statements regarding a crystal system.

1. All side lengths of the crystal system are equal i.e. ($a = b = c$)
2. All angles in crystal system are equal i.e. ($\alpha = \beta = \gamma$)
3. None of the angle in crystal system is equal to 90°.

The kind of crystal system is

(a) Hexagonal (b) Triclinic

(c) Rhombohedral (d) Monoclinic

455. (c)

Rhombohedral system also called trigonal system has all sides of equal length, equal angles other than 90° and less than 120°.

Q.456 A certain region has magnetic permeability, $\mu = 5\,\mu_0$ where μ_0 is permeability of space and magnetic flux density $\vec{B} = 20e^{-y}\hat{a}_y$ mW/m^2, then the value of magnetization in region will be

(a) $\frac{4 \times 10^4}{\pi} e^{-y}\hat{a}_y$ A/m (b) $\frac{5 \times 10^4}{\pi} e^{-y}\hat{a}_y$ A/m

(c) $\frac{2 \times 10^4}{\pi} e^{-y}\hat{a}_y$ A/m (d) $\frac{10^4}{\pi} e^{-y}\hat{a}_y$ A/m

456. (a)

Magnetic flux density is given by,

$$B = \mu H$$

$$H = \frac{B}{\mu} = \frac{20e^{-y} \times 10^{-3}\hat{a}_y}{5 \times 4\pi \times 10^{-7}} = \frac{1}{\pi}10^4 e^{-y}\hat{a}_y$$

$$\mu_r = \frac{\mu}{\mu_0} = 5$$

$$\chi_m = (\mu_r - 1) = 5 - 1 = 4$$

$$\text{Magnetization, } M = \chi_m H = 4\left(\frac{10^4}{\pi}e^{-y}\hat{a}_y\right) = \frac{4 \times 10^4}{\pi}e^{-y}\hat{a}_y \text{ A/m}$$

Q.457 Which of the given below statements are correctly stated regarding power loss occurring in dielectric?

(a) Power loss in dielectric is inversely proportional to frequency.

(b) Power loss in dielectric is proportional to square of volume of dielectric used.

(c) Power loss in dielectric is proportional to square of loss tangent i.e. $(\tan \delta)^2$.

(d) Power loss in dielectric is proportional to square of applied electric field.

457. (d)

Power loss in dielectric, $P_L = (2\pi \epsilon_0)E^2(A \cdot d)f \epsilon_r' \tan\delta$

So, $P_L \propto E^2$

$\therefore$ Option (d) is correct.

Q.458 Which of the given below relation correctly relates Hall angle 'θ_H' to mobility in semiconductor material and magnetic flux density?

(a) $\theta_H = \tan^{-1} \mu B$ (b) $\theta_H = \tan^{-1}\frac{\mu}{B}$

(c) $\theta_H = \sin^{-1} \mu B$ (d) $\theta_H = \sin^{-1}\frac{\mu}{B}$

458. (a)

Using conductivity equation,

$$\tan \theta_H = \mu B$$

Where, μ = mobility

B = magnetic flux density

$\therefore$ Hall angle, $\theta_H = \tan^{-1}(\mu B)$

Q.459 Consider the following statements regarding phenomena of polarization in solid dielectrics:
1. Clausius Mossotti equation relates electronic polarization with relative permittivity.
2. Only ionic polarization can occur in dielectric solids consisting of alkali halides.
3. Orientation polarization does not occur in nitrobenzene before melting point as dipoles are rigidly fixed in opposite direction.

Which of the above statement(s) is/are correct?
(a) 2 only (b) 3 only
(c) 1 and 3 only (d) 1 and 2 only

459. (c)
Ionic and electronic polarization both are possible in ionic solid dielectrics.

Q.460 A conduction wire made of isotropic conducting material having relaxation time of electron 9.1×10^{-14} seconds. Mass and charge of an electron are 9.1×10^{-31} kg and 1.6×10^{-19} C then mobility of electrons and their drift velocity when electric field applied to conductor is 1 V/cm, will be respectively

(a) $1.6\times10^{-2}\,\frac{m^2}{V\,\text{sec}}$, 1.2 m/sec (b) $1.2\times10^{-2}\,\frac{m^2}{V\,\text{sec}}$, 1.2 m/sec
(c) $1.2\times10^{-2}\,\frac{m^2}{V\,\text{sec}}$, 1.6 m/sec (d) $1.6\times10^{-2}\,\frac{m^2}{V\,\text{sec}}$, 1.6 m/sec

460. (d)
We know,

$$\text{Mobility of electrons, } \mu_e = \frac{e\tau}{m}$$

Where, τ : relaxation time of electron
e : charge on a electron
m : mass of electron

$$\mu_e = \frac{1.6\times10^{-19}\times9.1\times10^{-14}}{9.1\times10^{-31}}$$
$$= 1.6 \times 10^{-2}\ \text{m}^2\ \text{V}^{-1}\ \text{sec}^{-1}$$

$$\text{Average drift velocity, } v = \frac{e\tau}{m}\cdot E = 1.6 \times 10^{-2} \times 1 \times 10^{2}$$
$$= 1.6\ \text{m/sec}$$

Where, E : applied electric field.

Q.461 Consider the following statements regarding superconductivity in materials:
1. In super conducting state a material exhibits highest value of entropy.
2. Meissner effect is due to zero resistance state in superconductor.
3. In super conducting state, the magnetic susceptibility of material is a negative value.

Which of the above statement(s) is/are **not** correct?
(a) 1 only (b) 3 only
(c) 1 and 2 only (d) 1 and 3 only

461. (c)

- Entropy of material at superconducting state is minimum.
- Perfect diamagnetism and zero resistivity are two independent properties of super conducting state, and Meissner effect is not due to zero resistance state in superconductor.

Q.462 Consider the following statements regarding carbon nano-tubes:

1. Carbon nano-tubes have low tensile strength owing one double and two single bonds.
2. Nature of Carbon nano-tubes can be insulating, semiconducting or conducting depending on chirality of nano-tubes.
3. Carbon nano-tubes, also known as bucky tubes are represented by symbol 'C_{60}'.

Which of the above statements are **not** correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

462. (c)

Carbon nano-tubes have high tensile strength. C_{60} is representation of buckminister fullerene, also called bucky ball, spherical in shape.

Q.463 The magnetic moment in units of Bohr magneton of a ferrous ion in any ferrite is:

(a) zero (b) 2
(c) 4 (d) 6

463. (c)

The electronic configuration of ferrous ion is Fe^{2+} : $1s^2$, $2s^2\,2p^6$, $3s^2\,3p^6$, $3d^6$

The no. of electrons in outermost orbit is 6

$\therefore$ No. of unpaired electrons = 4

$\therefore$ Magnetic moment = 4 B.M.

Q.464 A piezoelectric crystal has an Young's modulus of 130 GPa. The uniaxial stress that must be applied to increase its polarization from 500 to 520 cm^{-2} is

(a) 5.2 GPa (b) 2.6 GPa
(c) 2.55 GPa (d) 1.15 GPa

464. (a)

$$\text{Uniaxial stress } (P) = Y \cdot \frac{\Delta C}{C}$$

$$\text{Charge, } q = CV$$

Now, $$\text{Polarization; } P = \frac{q}{A} = \frac{C}{A} \cdot V$$

Where A is area of the crystal capacitor.

$$\therefore \quad \Delta P = \left(\frac{V}{A}\right) \times \Delta C$$

So, $$\frac{\Delta P}{P} = \frac{\Delta C}{C}$$

$$\text{Stress } (P) = \gamma \cdot \frac{\Delta P}{P} = \frac{130 \times 20}{500} = 5.2 \text{ GPa}$$

Q.465 By inserting a slab of dielectric material between the plates of a parallel plate capacitor, the energy stored in the capacitor has increased by 6 times. The dielectric constant of the material is increased by a factor of

(a) $\sqrt{6}$ (b) 6
(c) 36 (d) 4

465. (b)

Energy stored in a capacitor,

$$E = \frac{1}{2}CV^2$$

So, $E \propto C$

Also, $C = \frac{\varepsilon A}{d}$; $C \propto \varepsilon$

Hence $E \propto \varepsilon$

$\therefore$ As energy stored is increased by 6 times, the dielectric constant of the materials is also increased by 6 times.

Q.466 Consider the following statements:

1. Magnetic susceptibility in paramagnetic materials is inversely related with temperature.
2. Some paramagnetic materials follow Curie-Weiss law given by $\chi_m = \frac{C}{T - \theta}$.

Which of the above statement(s) is/are correct?

(a) 1 only (b) both 1 and 2
(c) 2 only (d) neither 1 nor 2

466. (b)

Both statements are correct.

Q.467 Consider the following statements:

1. In anti ferro electric materials dipoles are aligned in anti parallel direction and they are unequal in magnitudes.
2. Anti ferro electric materials possess zero spontaneous polarization.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only
(c) both 1 and 2 (d) neither 1 nor 2

467. (b)

In Anti ferro electric materials, dipoles are aligned in anti parallel direction and they are equal in magnitude.

Q.468 Consider the following statements:

1. If susceptibility is negative, magnetic field is repelled away by the material.
2. If susceptibility is positive, magnetic field is attracted by the material.

Which of the above statements is/are correct?

(a) both 1 and 2 (b) 2 only
(c) 1 only (d) neither 1 nor 2

468. (a)

Both 1 and 2 are correct statements.

Q.469 Consider the following statements:

1. A pyroelectric material exhibits spontaneous polarization and changes its polarization on heating.
2. Every pyroelectric materials is piezoelectric material and vice versa.

Which of the above statement(s) is/are correct?

(a) 1 only (b) 2 only
(c) both 1 and 2 (d) neither 1 nor 2

469. (a)

- Polarization of a pyroelectric material changes on heating.
- Every pyroelectric material is piezoelectric material but converse is not true.

Q.470 Which one of the following computer architecture is not in the practice?

(a) SISD (b) SIMD
(c) MISD (d) MIMD

470. (c)

System contain multiprocessors but only one processor is in the use at a time.

Q.471 Which of the following is true?

(a) Immediate addressing mode is used to initialize variable.
(b) Index addressing mode are faster than direct addressing mode.
(c) Relative addressing suits for the special locally.
(d) Both (a) and (c)

471. (d)

- Immediate addressing mode used to initialize variable i.e. int $a = 20$. So it is true.
- Direct addressing mode are faster than index addressing modes, since no address calculation.
- If memory references are relatively near to the instruction being executed, then use of relative addressing saves address bits in the instruction. So, it is true.

Q.472 A 4-way set associative cache memory consists of 128 blocks. The main memory consist of 32768 memory blocks and each block contain 512 eight bit words. Find how many bits are needed to represent TAG, SET and WORD field respectively?

(a) 5, 9, 10 (b) 10, 6, 8
(c) 10, 9, 5 (d) 10, 5, 9

472. (d)

Main memory size = 32768 blocks

1 block = 512 words

= 32768 × 512 words = $2^{15} \times 2^9 = 2^{24}$ words

Main memory takes 24 bits.

Block size = 512 words = 2^9 words

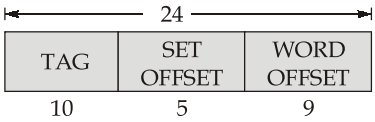
Number of bits for block size (Word Offset) = 9 bits.

Number of blocks in set associative = 128

Number of blocks in one set = 4

Number of sets in cache = 128 / 4 = 32 = 2^5

Number of bits in set offset = 5 bits



Number of TAG bits = 24 – (9+5) = 10 bits.

Q.473 Which of the following is correct output for the program code given below?

```
main ( )
{
    void fun ( );
    fun( );
    fun ( );
}
void fun ( );
{
    static int i = 1;
    auto int j = 5;
    printf ("%d", (i++));
    printf ("%d", (j++));
}
```

(a) 1 5 2 6 3 7 (b) 2 6 3 7 4 8

(c) 1 5 6 1 7 1 (d) 1 5 2 5 3 5

473. (d)

An object whose storage class is auto, is reinitialized at every function call whereas an object whose storage class static persist its value between different function calls.

When the function fun ( ) is called for the first time, value of *i* and j are printed and sequentially incremented. During the second function call, *i* retains its incremented value whereas j is reinitialized, hence *i* will print 2 and j will print 5 again. The same will happen at third function call, *i* will print 3 and j will print 5.

Q.474 Consider a 16-bit processor in which the following one address instruction is loaded into main memory :

100	Opcode
101	300
102	Next instruction
	M
200	800

What is the effective address using PC-relative addressing mode when processor is executing an instruction at location 100 ? (Assume memory is of Byte addressable).

(a) 350 (b) 400

(c) 402 (d) 420

474. (c)

Since address is of 16-bit. So skip 2 Bytes

In PC-relative mode:

$$\text{Effective address} = \text{Address field value (ACC)} + PC$$
$$= 300 + 102 = 402$$

Q.475 Main memory can transfer blocks of size 4 bytes each to cache where cache memory can hold 64 kilobytes. How many lines are there in cache?

(a) 2^{10} (b) 2^{12}

(c) 2^{14} (d) 2^{16}

475. (c)

$$\text{Cache size} = 64 \text{ kilobytes} = 64 \times 2^{10} \text{ bytes}$$
$$\text{Block size} = 4 \text{ bytes}$$

$$\text{Number of lines} = \frac{64 \times 2^{10}}{4} = 2^{14}$$

Q.476 Consider the following page reference string:

1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6

Assume there are 4 frames and initially all are empty. The number of page faults that would occur with optimal page replacement algorithm?

(a) 5 (b) 6

(c) 7 (d) 8

476. (d)

4	5	6	6	6
3	3	3	3	3
2	2	2	2	2
1	1	1	7	1

4 + 1 + 1 + 1 + 1 = 8

Q.477 If an instruction takes 2 milliseconds and a page fault takes an additional 3 milliseconds, the effective instruction time if the page fault occurs every 5 instruction is _____ msec.

(a) 1.6 (b) 2.6

(c) 3.6 (d) 4.6

477. (b)

Effective time = (Page fault rate × service time) + [(1 – page fault rate) × memory access time]

$$= \left[\frac{1}{5}\times(2+3)\right]+\left[\left(1-\frac{1}{5}\right)\times 2\right]$$

$$= 1+\frac{8}{5} = 2.6 \text{ msec}$$

Q.478 Assume all process arrive at $t = 0$, use Round Robin scheduling and time slice of $t = 50$ ms to schedule the process listed below:

Process 'A' requests 150 ms of burst time. Process 'B' request 60 ms of burst time. Process 'C' request 100 ms of burst time. What is average wait per process in the schedule above?

(a) 147.67 ms (b) 151.67 ms

(c) 106.67 ms (d) 156.67 ms

478. (d)

W.T. = T.A.T – B.T.

A	B	C	A	B	C	A

$t = 0$ 50 100 150 200 210 260 310

$W_A = 310 - 150 = 160$

$W_B = 210 - 60 = 150$

$W_C = 260 - 100 = 160$

$$W_{avg} = \frac{160+150+160}{3} = 156.67 \text{ ms}$$

Q.479 DMA is transferring characters to the processor, from a device transmitting at 16000 bits per second. Assume DMA is using cycle stealing. If the processor needs access to main memory once every micro second, how much percentage will the processor be slow down due to DMA activity? (1 character takes 500 micro seconds)

(a) 0.2% (b) 2%

(c) 20% (d) 40%

479. (a)

It is transferring 16000 bits in 1 second.

1 character takes 500 micro seconds.

∴ Processor accesses main memory in every micro second.

$$\therefore \quad \frac{1}{500}\times 100\% = 0.2\%$$

Q.480 Disk requests come into the disk driver for cylinders in the order: 10, 22, 20, 2, 40, 6, 38. The disk has 60 total cylinders and the disk head is currently positioned over cylinder 20. A seek takes 6 milliseconds per cylinder moved. What is the total seek time (in ms)

(a) 350 (b) 348
(c) 354 (d) 342

480. (b)

Difference between consecutive disk cylinders

$$\begin{matrix} 20, & 22, & 38, & 40, & 10, & 6, & 2 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 0 + & 2 + & 16 + & 2 + & 30 + & 4 + & 4 = 58 \text{ cylinders} \end{matrix}$$

$\therefore$ Total seek time $= 58 \times 6 = 348$ ms

Q.481 A computer has 32-bit instruction format which is shown below:

Opcode	Destination Register	Source Register	Immediate

Assume there are 205 different instructions on machine and 128 registers. The number of bits required for immediate field is

(a) 10 (b) 11
(c) 12 (d) 13

481. (a)

$\log_2 (205) \approx 8$

$\log_2 (128) = 7$

Opcode (8)	Destination (7)	Source (7)	Immediate (10)

32

$\therefore$ 10 bits required for immediate field.

Q.482 Consider a paging system with page table stored in memory. If a memory reference takes 200 ns. How long (in nano seconds) does a page memory reference takes?

(a) 200 ns (b) 300 ns
(c) 400 ns (d) 600 ns

482. (c)

2 memory references needed one for page table and other for the page.

$\therefore$ Time $= 200 \text{ ns} + 200 \text{ ns} = 400 \text{ ns}$

Q.483 $(0.11)_2$ is equivalent to _____ in octal system.

(a) 0.50 (b) 0.60
(c) 0.70 (d) 0.55

483. (b)

$(0.11)_2 = 2^{-1} + 2^{-2} = (0.75)_{10}$

$0.75 \times 8 = 6.0 \rightarrow$ (carry 6)

$(0.75)_{10} = (0.60)_8$

Q.484 Consider the following statements:

1. Pre-fetching is a process in which data is temporarily held to be used and executed by a device, program or system, for simultaneous peripheral operations.
2. Spooling is a method of overlapping the I/O of a job with that job's own computation.

Which of the above is/are **not** correct?

(a) 1 only (b) 2 only
(c) 1 and 2 both (d) neither 1 nor 2

484. (c)

Prefetching : Method of overlapping the I/O of job with that of job's own computation.

Spooling : CPU overlaps the input of one job with the computation and output.

Q.485 Consider the following statements:

1. Instruction cycle, describes execution sequence of a program, contains 2 sub cycles.
2. In fixed length instruction supported CPU, program counter will be incremented to next sequential instruction address at the end of instruction decode state.
3. Instruction execution cycle consists of operand fetch, process data and write back.

Which of the above statements is/are correct?

(a) 1 and 3 only (b) 1 only
(c) 2 and 3 only (d) 1, 2 and 3

485. (a)

Program counter is incremented by 1 at the end of instruction fetch cycle.

Q.486 Which of the following is **not** a fundamental data type in C++ ?

(a) float (b) string
(c) int (d) char

486. (b)

Q.487 When a process is busy swapping pages in and out, then this situation is called

(a) Thrashing (b) Compaction
(c) External fragmentation (d) Division

487. (a)

Thrashing is the term used whenever a process is busy swapping pages in and out.

Q.488 Consider the following multiplication:

$(110XY)_2 * (5)_{10} = (10000Z11)_2$

What are the values of X, Y, Z respectively

(a) 0, 1, 1 (b) 1, 0, 1
(c) 1, 1, 0 (d) 1, 1, 1

488. (d)

$(110XY)_2 * (101)_2 =$

$$\begin{array}{cccccccc} & & 1 & 1 & 0 & X & Y & \\ & 1 & 1 & 0 & X & Y & & \\ \hline 1 & 0 & 0 & 0 & 0 & Z & 1 & 1 \end{array}$$

$\therefore \quad Y = 1$

$X = 1$

Also, $Z = Y$

$\therefore \quad Z = 1$

Q.489 A signal $m(t) = 5\cos(200\pi t)$ frequency modulates a carrier. The resulting FM signal is $10\cos[2\pi \times 10^5 t + 15\sin(200\pi t)]$. The approximate bandwidth of FM signal would be?

(a) 0.1 kHz (b) 1 kHz

(c) 3.2 kHz (d) 100 kHz

489. (c)

$f_m = 100$ Hz

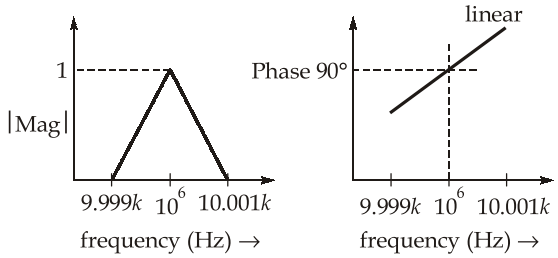
$m_f = 15$

Bandwidth $= 2(m_f + 1) f_m = 2[15 + 1] \times 100$

$= 3.2$ kHz

Q.490 A carrier of frequency 1 MHz is amplitude modulated by a signal of frequency 1 kHz to a depth of 60%. This is passed through a filter of characteristics shown in the given figure (a) and figure (b).

If the filter output is fed to an envelope detector, the detector output will be



(a) zero (b) DC

(c) 1 kHz signal (d) DC + 1 kHz signal

490. (b)

When the resultant AM signal is passed through the given filter, the output of the filter will be the sinusoidal carrier signal with 90° phase shift.

When this resultant sinusoidal carrier signal is passed through an envelope detector, the output of envelope detector will be a DC signal.

Q.491 In a broadcast transmitter, the RF output is represented as

$e(t) = 50[1 + 0.89\cos 5000t + 0.30\sin 9000t]\cos(6 \times 10^6 t)$ Volt.

What are the sidebands of the signals in radians?

(a) 5×10^3 and 9×10^3

(b) 5.991×10^6, 5.955×10^6, 6.005×10^6 and 6.009×10^6

(c) 4×10^3 and 1.4×10^4

(d) 1×10^6, 1.1×10^7, 3×10^6 and 1.5×10^7

491. **(b)**

Sidebands are $\omega_c \pm \omega_{m_1}$ and $\omega_c + \omega_{m_2}$

$6 \times 10^6 \pm 5 \times 10^3$ and $6 \times 10^6 \pm 9 \times 10^3$

6.005×10^6 , 5.995×10^6, 6.009×10^6, and 5.991×10^6

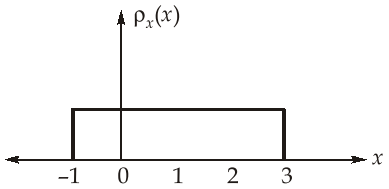
Q.492 A signal contains components at 400 Hz and 2400 Hz. This signal modulates a carrier of frequency 100 MHz. However, after demodulation it is found that the 400 Hz signal component is present. The channel bandwidth is 15 kHz. What is the reason for higher frequency signal not to be detected properly?

(a) Modulation used is FM and bandwidth is insufficient.
(b) Modulation used is AM and bandwidth is insufficient.
(c) Modulation used is FM but pre-emphasis is not used.
(d) Modulation used is FM but detector is for FM.

492. **(c)**

In FM, the amplitude of higher frequency components reduces significantly. So the high frequency components are lost if not boosted before transmission which is called pre-emphasis.

Q.493 For a random variable X having the probability density function (PDF) as shown in the below figure. What are the values of mean and the variance, respectively?



(a) $\frac{1}{2}$ and $\frac{2}{3}$ (b) 1 and $\frac{4}{3}$

(c) 1 and $\frac{2}{3}$ (d) 2 and $\frac{4}{3}$

493. **(b)**

Mean value,

$$\bar{X} = \int_{-\infty}^{\infty} x \cdot \rho_x(x)\,dx = \frac{1}{4}\int_{-1}^{3} x\,dx = \frac{1}{4}\cdot\frac{x^2}{2}\Big|_{-1}^{3} = 1$$

Variance, $$\overline{X^2} = \int_{-\infty}^{\infty} x^2 \rho_x(x)\,dx = \frac{1}{4}\int_{-1}^{3} x^2\,dx = \frac{1}{4\times 3}\cdot x^3\Big|_{-1}^{3} = \frac{1}{12}(27+1)$$

$$= \frac{28}{12} = \frac{7}{3}$$

Variance, $\overline{X^2} - \left(\bar{X}\right)^2 = \frac{7}{3} - 1 = \frac{4}{3}$

Q.494 A received single-tone sinusoidally modulated SSB SC signal $\cos(\omega_c+\omega_m)t$ has normalized power of 0.5 volt. The signal is to be defected by carrier reinsertion technique. Find the amplitude of the carrier to be reinserted so that the power in the recovered signal at the modulator output is 90% of the normalized power. The DC component can be neglected and $\omega_c = 2\pi f_c$ and $\omega_m = 2\pi f_m$.

(a) 10.15 (b) 3.16

(c) 2.2 (d) 3.00

494. (d)

$$s'(t) = s(t) + c(t)$$

$$s'(t) = [A + \cos\omega_m t]\cos\omega_c t - \sin\omega_c t \,.\, \sin\omega_m t$$

$$V(t) = \sqrt{(A+\cos\omega_m t)^2 + (\sin\omega_m t)^2}$$

Demodulator output, $V(t) = \sqrt{A^2+1} + \dfrac{A}{\sqrt{A^2+1}}\cos\omega_m t$

Neglecting DC component, $P_d = \dfrac{1}{2}\cdot\dfrac{A^2}{A^2+1} = 0.9 \times P_n = 0.9 \times 0.5 = 0.45$

$\therefore \quad A = 3$

Q.495 A source delivers symbols X_1, X_2, X_3, X_4 with propabilities $\frac{1}{2},\frac{1}{4},\frac{1}{8},\frac{1}{8}$ respectively. The entropy of the system is

(a) 1.75 bits/second (b) 1.75 bits/symbol

(c) 2.75 symbols/second (d) 2.75 symbols/bit

495. (b)

$$\text{Entropy, } H = \frac{1}{2}\log_2 2 + \frac{1}{4}\log_2 4 + \frac{1}{8}\log_2 8 + \frac{1}{8}\log_2 8$$

$$H = 1.75 \text{ bits/symbol}$$

Q.496 The spectrum in the range (550 to 1650) kHz is allocated for AM radio broadcasting and the spectrum is shared for different AM radio stations using frequency division multiplexing (FDM). If the message signal of each AM radio station is band-limited to 5 kHz, then the maximum number of different AM radio stations that can be enjoyed by a listener will be equal to

(a) 11 (b) 55

(c) 110 (d) 220

496. (c)

Given that, $f_{m\,(\max)} = 5$ kHz

Bandwidth required for each AM radio station is,

$$(BW)_{AM} = 2f_{m\,(\max)} = 10 \text{ kHz}$$

Total spectrum bandwidth available is,

$$(BW)_{Total} = 1650 - 550 = 1100 \text{ kHz}$$

Total number of AM radio stations possible is,

$$N = \frac{1100 \text{ kHz}}{10 \text{ kHz}} = 110$$

Q.497 Which one of the following is **not** the purpose of modulation?

(a) To provide the feasibility for multiplexing.
(b) To reduce the antenna height for effective radiation.
(c) To increase the signal power.
(d) For narrow banding the transmitted signal.

497. (c)

Modulation is not required to increase the signal power. Simple amplification also can increase the signal power.

Direction (Q.498 to Q.500): The following items consists of two statements, one labelled as **Statement (I)** and the other labelled as **Statement (II)**. You have to examine these two statements carefully and select your answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are true but Statement (II) is **not** a correct explanation of Statement (I).
(c) Statement (I) is true but Statement (II) is false.
(d) Statement (I) is false but Statement (II) is true.

Q.498 **Statement (I):** Soft magnetic materials favour rapid switching of magnetization to the applied AC field.
Statement (II): Soft magnetic materials are easy to magnetize and demagnetize.

498. (a)

Both the statements are correct and statement-II is correct explanation of statement-I.

Q.499 **Statement (I):** Routers are the networking devices that are used at network layer.
Statement (II): Routers find the best route for all the data sent to them by the previous router or the end station of the LAN.

499. (a)

Routers are used at Network layer to perform the routing function. With the help of routing tables find the best route for all the data sent to them by the previous router or at the end station of the LAN.

Q.500 **Statement (I):** Vestigial Sideband (VSB) modulation is used for TV broadcasting.
Statement (II): Video signals have negligible power at low frequencies.

500. (c)

Video signals do not have negligible power at low frequencies.

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