

Roll No.

Question Booklet Number

O. M. R. Serial No.

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M. Sc. (Electronics) (Second Semester)

EXAMINATION, July, 2022

ELECTROMAGNETICS, ANTENNA & MICROWAVE THEORY

Paper Code

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Questions Booklet
Series

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Time : 1:30 Hours]

[Maximum Marks : 100

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.
2. The booklet contains 60 questions. Examinee is required to answer any 50 questions in the OMR Answer-Sheet provided and not in the question booklet. If more than 50 questions are attempted by student, then the first attempted 50 questions will be considered for evaluation. All questions carry equal marks.
3. Examine the Booklet and the OMR Answer-Sheet very carefully before you proceed. Faulty question booklet due to missing or duplicate pages/questions or having any other discrepancy should be got immediately replaced.

परीक्षार्थियों के लिए निर्देश :

1. प्रश्न-पुस्तिका को तब तक न खोलें जब तक आपसे कहा न जाए।
2. प्रश्न-पुस्तिका में 60 प्रश्न हैं। परीक्षार्थी को किन्हीं 50 प्रश्नों को केवल दी गई OMR आन्सर-शीट पर ही हल करना है, प्रश्न-पुस्तिका पर नहीं। यदि छात्र द्वारा 50 से अधिक प्रश्नों को हल किया जाता है तो प्रारम्भिक हल किये हुए 50 उत्तरों को ही मूल्यांकन हेतु सम्मिलित किया जाएगा। सभी प्रश्नों के अंक समान हैं।
3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR आन्सर-शीट को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका जिसमें कुछ भाग छपने से छूट गए हों या प्रश्न एक से अधिक बार छप गए हों या उसमें किसी अन्य प्रकार की कमी हो, तो उसे तुरन्त बदल लें।

(Remaining instructions on the last page)

(शेष निर्देश अन्तिम पृष्ठ पर)

(Only for Rough Work)

1. If the wave number of a medium is 20 and loss tangent is 0.4, then the dielectric loss caused by the medium is :
 (A) 4
 (B) 2
 (C) 3
 (D) 6
2. The loss that occurs in a transmission line is :
 (A) Conduction losses
 (B) Dielectric loss
 (C) Both of the mentioned
 (D) None of the mentioned
3. If $p = 0.3$ and the wave number of air in TM mode is 16, then the intrinsic impedance of air in TM mode given wave number is 125 is :
 (A) 1Ω
 (B) 0.9Ω
 (C) 0.8Ω
 (D) 2Ω
4. If the wave impedance of a medium is 200Ω , then what is the relative permittivity of that medium ?
 (A) 1.885
 (B) 2
 (C) 2.2
 (D) 2.5
5. If the wavelength of a signal is 10 mm, then the wave number of the material when a waveguide is filled with that material is :
 (A) 628
 (B) 345
 (C) 123
 (D) None of the mentioned
6. In a radar when the return echo arrives after the allocated pulse interval, then
 (A) The receiver will get overloaded.
 (B) It may interfere with the operation of the transmitter.
 (C) The target will appear closer than it really is.
 (D) It will not be received.
7. The waveguide tuning component, which is not easily adjustable, is :
 (A) Screw
 (B) Iris
 (C) Stub
 (D) Plunger
8. Two entities that are combined to form a Magic Tee are :
 (A) One H and two E plane tees
 (B) One H and one E plane tee
 (C) Two H and two E plane tees
 (D) Two H and one E plane tee

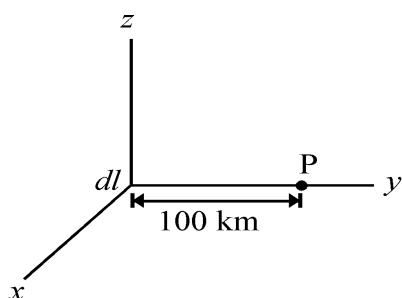
9. Microwave energies propagate the length of the waveguide by its side walls.
- (A) Refraction off
 - (B) Reflection off
 - (C) Moving off
 - (D) None of the above
10. Consider two identical antennas 1000 m apart for measuring the gain of the transmitting antenna at 3 GHz. Assume that the mainlobes of both the antennas are aligned such that maximum power can be transferred. It is given that the ratio of received power to the transmitted power is equal to 10^{-3} . Then find the gain of the transmitting antenna in dB :
- (A) 35.98 dB
 - (B) 45.98 dB
 - (C) 25.98 dB
 - (D) 71.97 dB
11. A rectangular waveguide of dimension $a = 2.286$ cm and $b = 1.016$ cm is mounted on an infinite ground plane at $z = 0$. Determine the first Null-to-Null beamwidth in $\theta = \pi / 2$ plane if the waveguide is operating 10 GHz and it has uniform field distribution over the aperture :
- (A) 2.95 radian
 - (B) 5.9 radian
 - (C) 1.23 radian
 - (D) does not exist in the visible region
12. Equivalence principle follows which of the following theorems ?
- (A) Gauss Theorem
 - (B) Friis Theorem
 - (C) Poynting Theorem
 - (D) Uniqueness Theorem
13. The area of an aperture antenna with high directivity an efficiency should be :
- (A) $\geq \lambda^2$
 - (B) $\geq 1 / \lambda$
 - (C) $\leq \lambda^2$
 - (D) $\leq \lambda$
14. The microstrip antenna has :
- (A) high gain narrow bandwidth
 - (B) high gain high bandwidth
 - (C) low gain narrow bandwidth
 - (D) low gain high bandwidth
15. For a rectangular aperture mounted on an infinite ground plane (with $a = 4\lambda, b = 3\lambda$), compute the half power beamwidth in the E plane :
- (A) 22.86 degrees
 - (B) 14.65 degrees
 - (C) 16.93 degrees
 - (D) 12.70 degrees

16. For a rectangular aperture mounted on an infinite ground plane, compute the directivity when $a = 3\lambda, b = 2\lambda$:
- (A) 18.77 dB
(B) 19.54 dB
(C) 10.26 dB
(D) 20.96 dB
17. A two-element array of isotropic sources has the phase difference of $\pi / 2$ and equal magnitudes. The spacing between the elements is $d = \lambda / 2$. Find the simplified expression for the antenna array factor :
- (A) $\cos(\pi / 2 \sin \theta \cos \phi + \pi / 4)$
(B) $\cos(\pi / 2 \sin \theta \cos \phi + \pi / 2)$
(C) $\cos(\pi / 4 \sin \theta \cos \phi + \pi / 4)$
(D) $\cos(\pi / 4 \sin \theta \cos \phi + \pi / 2)$
18. The directivity of a quarter wave monopole antenna is :
- (A) exactly half of that of the half wave dipole antenna.
(B) approximately equal to that of the half wave dipole antenna.
(C) exactly twice of that of the half wave dipole antenna.
(D) approximately one third of that of the half wave dipole antenna.
19. A linear half-wavelength dipole is operating at frequency of 5 GHz; determine the capacitance or inductance that must be placed in series of the dipole so that the antenna becomes resonant :
- (A) 6.75 nF
(B) 0.675 nF
(C) 1.35 nF
(D) 2.7 nF
20. A center-fed electric dipole of length l is attached to a balanced lossless transmission line whose characteristic impedance is 50 ohms. Assuming the dipole is resonant at the given length, find the input VSWR when $l = \lambda$:
- (A) 1.46
(B) 1
(C) ∞
(D) 3.65

21. If a small single turn loop antenna has radiation resistances of 0.04Ω , how many turns are needed to produce a radiation resistance of 1Ω ?

- (A) 5
- (B) 25
- (C) 50
- (D) 125

22. A half wave dipole antenna is located at the origin as shown in figure below. The antenna is fed by a current $i(t) = 83.3 \cos \omega t \text{ mA}$. What will be the electric field strength at point P ?



- (A) 25 mV/m
- (B) 50 mV/m
- (C) $50 \mu\text{V/m}$
- (D) $2.5 \mu\text{V/m}$

23. The effective antenna temperature of an antenna looking toward zenith is approximately 5 K. Assuming that the temperature of the transmission line (waveguide) is 720 F, find the effective temperature at the receiver terminals when the attenuation of the transmission line is 4 dB/100 ft and its length is 2ft :

- (A) 10.92 K
- (B) 10.29 K
- (C) 12.55 K
- (D) 20.69 K

24. Two identical antenna separated by 12 m are oriented for maximum directive gain. At a frequency of 5 GHz, the power received by one is 30 dB down from the transmitted by other. The gain of the antenna is :

- (A) 22 dB
- (B) 16 dB
- (C) 19 dB
- (D) 13 dB

25. The power transmitted by a synchronous orbit satellite antenna is 480 W. The antenna has a gain of 40 dB at 15 GHz. The earth station is located at distance of 24567 km. If the antenna of the earth station has a gain of 32 dB, the power received is :
- (A) 32 pW
 - (B) 3.2 fW
 - (C) 10.2 pW
 - (D) 1.3 fW
26. The directivity of a half wave dipole is given by :
- (A) 1.64
 - (B) 3.47
 - (C) 2.03
 - (D) 2.54
27. If the antenna has a main half-power beamwidth (HPBW) = 20° in both principal planes, its directivity is :
- (A) 20 dBi
 - (B) 10 dBi
 - (C) 15 dBi
 - (D) 25 dB
28. Directivity is the :
- (A) Maximum power gain
 - (B) Minimum power gain
 - (C) Maximum directive gain
 - (D) Minimum directive gain
29. The terminology used for antenna field zones is :
- (A) Near field or Fraunhofer zone and far field or Fresnel zone
 - (B) Near field or Fresnel zone and far field or Fraunhofer zone
 - (C) Near field or Friis zone and far field or Fraunhofer zone
 - (D) Near field or Fresnel zone and far field or Friis zone
30. An incoming wave, with a uniform power density equal to $0.54 \times 10^{-3} \text{ W/m}^2$ is incident normally upon a lossless horn antenna whose directivity is 22 dB. At a frequency of 12.5 GHz, determine the very maximum possible power that can be expected to be delivered to a receiver or a load connected to the horn antenna. There are no losses between the antenna and the receiver or load :
- (A) 7.87 μW
 - (B) 5.24 μW
 - (C) 3.91 μW
 - (D) 9.97 μW

31. Calculate the e.m.f. of a material having a flux linkage of $2t^2$ at time $t = 1$ second :
- (A) 2
(B) 4
(C) 8
(D) 16
32. Which of the following relations holds good ?
- (A) $Bq = ILE$
(B) $E = ILBq$
(C) $Eq = ILB$
(D) $B = ILEq$
33. Maxwell's second equation is based on which law ?
- (A) Ampere's law
(B) Faraday's law
(C) Lenz's law
(D) Coulomb's law
34. Both the conduction and displacement current densities coexist in which medium ?
- (A) Only conductors in air
(B) Only dielectrics in air
(C) Conductors placed in any dielectric medium
(D) Both the densities can never coexist
35. An implication of the continuity equation of conductors is given by :
- (A) $J = \sigma E$
(B) $J = E/\sigma$
(C) $J = \sigma / E$
(D) $J = j\omega E\sigma$
36. Find the displacement current density of a material with flux density of $5 \sin t$:
- (A) $2.5 \cos t$
(B) $2.5 \sin t$
(C) $5 \cos t$
(D) $5 \sin t$
37. The Maxwell's second equation that is valid in any conductor is :
- (A) $\text{curl} (H) = Jc$
(B) $\text{curl} (E) = Jc$
(C) $\text{curl} (E) = Jd$
(D) $\text{curl} (H) = Jd$
38. Find the electric field intensity of a charge 2.5 C with a force of 3 N :
- (A) -7.5
(B) 7.5
(C) $2.5/3$
(D) $3/2.5$

39. Find the e.m.f. induced in a coil of 60 turns with a flux rate of 3 units :
- (A) - 60
(B) -180
(C) 60
(D) 180
40. The magnitude of the conduction current density for a magnetic field intensity of a vector $y_i + z_j + x_k$ will be :
- (A) 1.414
(B) 1.732
(C) - 1.414
(D) - 1.732
41. The line integral of which parameter is zero for static fields ?
- (A) E
(B) H
(C) D
(D) B
42. Which of the following relations is correct ?
- (A) $\text{MMF} = \int B.dl$
(B) $\text{MMF} = \int H.dl$
(C) $\text{EMF} = \int E.dl$
(D) $\text{EMF} = \int D.dl$
43. The distance between two successive points in a waveguide is the :
- (A) Guided wavelength
(B) $2 \times$ guided wavelength
(C) Guided wavelength/2
(D) (Guided wavelength)/4
44. The phase velocity of a wave having a phase constant of 4 units and a frequency of 2.5×10^9 radian/sec is (in 10^8 order) :
- (A) 3.25
(B) 3.75
(C) 6.25
(D) 6.75
45. The cut-off wavelength and the guided wavelength are given by 0.5 and 2 units respectively. Find the wavelength of the wave :
- (A) 0.48
(B) 0.32
(C) 0.45
(D) 0.54

46. Identify the polarisation of the wave given that, $E_x = 2 \sin \omega t$ and $E_y = 3 \sin \omega t$:
- (A) Linear
 - (B) Elliptical
 - (C) Circular
 - (D) Parallel
47. The magnitude of the E_x and E_y components are same in which type of polarisation ?
- (A) Linear
 - (B) Circular
 - (C) Elliptical
 - (D) Perpendicular
48. Which transmission line is called as one-to-one transformer ?
- (A) $L = \lambda$
 - (B) $L = \lambda/2$
 - (C) $L = \lambda/4$
 - (D) $L = \lambda/8$
49. The phase shift in the electric and magnetic fields in an EM wave is given by which parameter ?
- (A) Phase constant
 - (B) Attenuation constant
 - (C) Propagation constant
 - (D) Intrinsic impedance
50. The skin depth of a conductor with attenuation constant of 7 nepers/m is :
- (A) 14
 - (B) 49
 - (C) 7
 - (D) 1/7
51. The total permeability in a conductor is :
- (A) Absolute permeability
 - (B) Relative permeability
 - (C) Product of absolute and relative permeability
 - (D) Unity
52. The Brewster angle is expressed as :
- (A) $\tan^{-1}(n)$
 - (B) $\tan^{-1}(n_1 / n_2)$
 - (C) $\tan^{-1}(n_2 / n_1)$
 - (D) $\tan(n)$
53. The power of a wave of with voltage of 140 V and a characteristic impedance of 50 ohm is :
- (A) 1.96
 - (B) 19.6
 - (C) 196
 - (D) 19600

54. The power reflected by a wave with incident power of 16 units is (Given that the reflection coefficient is 0.5) :
- 2
 - 8
 - 6
 - 4
55. The basic requirements of transmitting antennas are :
- High efficiency
 - Low side lobes
 - Large signal to noise ratio
 - None of the mentioned
56. Expression for VSWR in terms of reflection coefficient is :
- $(1 + |\Gamma|) / (1 - |\Gamma|)$
 - $(1 - |\Gamma|) / (1 + |\Gamma|)$
 - $1 / |\Gamma|$
 - $1 / 1 + |\Gamma|$
57. Expression for a voltage reflection coefficient in terms of load impedance and characteristic impedance is :
- $(Z_L - Z_0) / (Z_L + Z_0)$
 - $(Z_L + Z_0) / (Z_L - Z_0)$
 - $Z_L \cdot Z_0 / (Z_L + Z_0)(Z_L - Z_0)$
 - $(Z_L + Z_0)(Z_L - Z_0) / Z_L \cdot Z_0$
58. Voltage reflection coefficient can be defined as :
- ratio of amplitude of reflected voltage wave to the transmitted voltage wave.
 - ratio of amplitude of reflected voltage to the incident voltage wave.
 - ratio of load impedance to the characteristic impedance of the transmission line.
 - None of the mentioned
59. We say a transmission line is matched when :
- $Z_L = Z_0$
 - $Z_L = \sqrt{Z_0}$
 - $Z_L = Z_0 / 2$
 - $Z_L = 2Z_0$
60. When a lossless line is terminated with an arbitrary load impedance Z_L , then it :
- causes wave reflection on transmission lines
 - transmits the entire supplied power
 - causes loss in transmission line
 - None of the mentioned

4. Four alternative answers are mentioned for each question as—A, B, C & D in the booklet. The candidate has to choose the most correct/appropriate answer and mark the same in the OMR Answer-Sheet as per the direction :

Example :

Question :

Q. 1 (A) ☒ (B) (C) (D)

Q. 2 (A) (B) ☒ (C) (D)

Q. 3 (A) ☒ (B) (C) (D)

Illegible answers with cutting and over-writing or half filled circle will be cancelled.

5. Each question carries equal marks. Marks will be awarded according to the number of correct answers you have.
6. All answers are to be given on OMR Answer sheet only. Answers given anywhere other than the place specified in the answer sheet will not be considered valid.
7. Before writing anything on the OMR Answer Sheet, all the instructions given in it should be read carefully.
8. After the completion of the examination candidates should leave the examination hall only after providing their OMR Answer Sheet to the invigilator. Candidate can carry their Question Booklet.
9. There will be no negative marking.
10. Rough work, if any, should be done on the blank pages provided for the purpose in the booklet.
11. To bring and use of log-book, calculator, pager and cellular phone in examination hall is prohibited.
12. In case of any difference found in English and Hindi version of the question, the English version of the question will be held authentic.

Impt. : On opening the question booklet, first check that all the pages of the question booklet are printed properly. If there is any discrepancy in the question Booklet, then after showing it to the invigilator, get another question Booklet of the same series.

4. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार सम्भावित उत्तर—A, B, C एवं D हैं। परीक्षार्थी को उन चारों विकल्पों में से एक सबसे सही अथवा सबसे उपयुक्त उत्तर छोटना है। उत्तर को OMR आन्सर-शीट में सम्बन्धित प्रश्न संख्या में निम्न प्रकार भरना है :

उदाहरण :

प्रश्न :

प्रश्न 1 (A) ☒ (B) (C) (D)

प्रश्न 2 (A) (B) ☒ (C) (D)

प्रश्न 3 (A) ☒ (B) (C) (D)

अपठनीय उत्तर या ऐसे उत्तर जिन्हें काटा या बदला गया है, या गोले में आधा भरकर दिया गया, उन्हें निरस्त कर दिया जाएगा।

5. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।
6. सभी उत्तर केवल ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर ही दिये जाने हैं। उत्तर-पत्रक में निर्धारित स्थान के अलावा अन्यत्र कहीं पर दिया गया उत्तर मान्य नहीं होगा।
7. ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर कुछ भी लिखने से पूर्व उसमें दिये गये सभी अनुदेशों को सावधानीपूर्वक पढ़ लिया जाये।
8. परीक्षा समाप्ति के उपरान्त परीक्षार्थी कक्ष निरीक्षक को अपनी OMR Answer Sheet उपलब्ध कराने के बाद ही परीक्षा कक्ष से प्रस्थान करें। परीक्षार्थी अपने साथ प्रश्न-पुस्तिका ले जा सकते हैं।
9. निगेटिव मार्किंग नहीं है।
10. कोई भी रफ कार्य, प्रश्न-पुस्तिका के अन्त में, रफ-कार्य के लिए दिए खाली पेज पर ही किया जाना चाहिए।
11. परीक्षा-कक्ष में लॉग-बुक, कैलकुलेटर, पेजर तथा सेल्युलर फोन ले जाना तथा उसका उपयोग करना वर्जित है।
12. प्रश्न के हिन्दी एवं अंग्रेजी रूपान्तरण में भिन्नता होने की दशा में प्रश्न का अंग्रेजी रूपान्तरण ही मान्य होगा।

महत्वपूर्ण : प्रश्नपुस्तिका खोलने पर प्रथमतः जाँच कर देख लें कि प्रश्न-पुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्षनिरीक्षक को दिखाकर उसी सिरीज की दूसरी प्रश्न-पुस्तिका प्राप्त कर लें।