BUDDHA SERIES

(Unit Wise Solved Question & Answers)

Course – B.Sc.Maths3rd year 5th Semester

College – Buddha Degree College

(DDU Code-859)

Department: Science

Subject: Tensor Analysis

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Unit-1

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1. In tensor transformation, the coordinates of a contravariant vector transform using:

A. The Jacobian of inverse transformation
B. The Jacobian of the direct transformation
C. A constant scalar
D. Both A and B

Answer: B

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2. Covariant components of a vector transform by:

A. The same rule as contravariant
B. The inverse Jacobian
C. A transpose matrix
D. The determinant

Answer: B

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3. A scalar invariant under transformation means:

A. It is zero
B. It remains same in all coordinate systems
C. It transforms as a tensor
D. It inverts sign

Answer: B

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4. Which of the following is a mixed tensor?

A. T^i_j
*B. T*ij
C. T^i
D. Scalar

Answer: A

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5. A symmetric second-order tensor satisfies:

A. T{ij} = -T{ji}
B. T{ij} = T{ji}
C. $T^{ij} = -T^{ji}$
D. None

Answer: B

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6. A skew-symmetric tensor has:

A. T{ij} + T{ji} = 0
B. Tij} = T{ji}
C. Both A & B
D. Neither

Answer: A

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7. Contraction of a tensor means:

A. Multiplication by a scalar
B. Summing over one contravariant and one covariant index
C. Differentiation
D. Transposition

Answer: B

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8. The inner product between two vectors A and B is:

A. A^iB_i
B. A_iB^i
C. Both A & B
D. A_iB_j

Answer: C

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9. The algebra of tensors involves:

A. Addition, multiplication, contraction
B. Only addition
C. Differentiation
D. Integration

Answer: A

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10. Quotient law helps to determine:

A. If a set of components form a tensor
B. The determinant of a tensor
C. Inverse of a transformation
D. The trace

Answer: A

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11. Reciprocal tensors are used to generate:

A. Covariant metrics
B. Contravariant metric tensor from covariant one
C. Scalars
D. Vectors

Answer: B

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12. The trace of a second-order tensor T^{ij} is:

A. $T_{\{ii\}}$
B. T^{ij}
C. $T_{\{ij\}}$ $T^{\{ji\}}$
D. $T^{\{ij\}}$ $T_{\{ij\}}$

Answer: B

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13. A tensor that does not change sign under coordinate reflection is:

A. Pseudotensor
B. True tensor
C. Antisymmetric tensor
D. Reciprocal tensor

Answer: B

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14. Covariant derivative involves:

A. Partial derivatives only
B. Christoffel symbols
C. Determinants
D. Contraction only

Answer: B

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15. A tensor with all lower indices is:

A. Contravariant
B. Covariant
C. Mixed
D. Reciprocal

Answer: B

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16. The determinant of transformation appears in:

A. Rank-2 tensor transform always
B. Transform of volume element
C. Covariant vector transform
D. Quotient law

Answer: B

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17. The metric tensor $g_{\{ij\}}$ is:

A. Skew-symmetric
B. Symmetric
C. Mixed
D. Scalar

Answer: B

---

18. The Levi-Civita tensor $\varepsilon_{\{ijk\}}$ is:

A. Scalar
B. Symmetric
C. Skew-symmetric
D. Mixed

Answer: C

---

19. Outer product of two vectors yields:

A. Third-order tensor
B. Second-order tensor
C. Scalar
D. Mixed tensor

Answer: B

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20. Contraction reduces the order of a tensor by:

A. 2
B. 1
C. 0
D. It increases

Answer: B

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21. In the quotient law, if $A_{\{ij\}}B^{\{j\}}$ transforms as a tensor for any B^{j}, then:

A. $A^{\{ij\}}$ must be a scalar
B. $A_{\{ij\}}$ is a tensor
C. $B^{\{j\}}$ is scalar
D. None

Answer: B

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22. A mixed tensor $T^{\{i\}}_{\{j\}}$ has:

A. Both indices contravariant
B. Both indices covariant
C. One up, one down
D. No indices

Answer: C

---

23. Scalar invariants include:

A. Determinant of tensor
B. Trace
C. Norm of vector
D. All of the above

Answer: D

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24. A (0,2)-tensor is:

A. Contravariant
B. Covariant
C. Mixed
D. Scalar

Answer: B

---

25. A skew-symmetric tensor has zero:

A. Trace
B. Determinant
C. Index
D. Rank

Answer: A

---

26. The inverse metric tensor g^{ij} is:

A. Covariant
B. Contravariant
C. Mixed
D. Skew

Answer: B

27. The dot product A·B is a:

A. Tensor of type (1,1)
B. Scalar invariant
C. Mixed tensor
D. Skew tensor

Answer: B

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28. Quotient law is used to test:

A. Scalar products
B. Tensorial nature of unknown B if A·B is known
C. Metric invertibility
D. Orthogonality

Answer: B

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29. The algebra of tensors does NOT include:

A. Addition
B. Tensor product
C. Differential equations
D. Contraction

Answer: C

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30. Covariant and contravariant vectors differ by:

A. Their transformation rule
B. Their magnitude
C. Their trace
D. Being scalars

Unit-2

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1. The *associated tensor* of a vector Ai using the metric gijis:

A. Aj=gijAiAj
B. Aj=gijAiAj
C. Ai=gijAjAi
D. Aj=gjiAiAj

Answer: B

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2. The length of a vector A in Riemannian space is:

A. √AiAj
B.√gijAiAj
C. gijAiAj
D.√|Ai|

Answer: B

---

3. A unit vector satisfies:

A. ‖A‖=1
B. gijAiAj=0
C. AiAi=0
D. Ai=gijAjA_i

Answer: A

---

4. A null (isotropic) vector has length:

A. 1
B. -1
C. 0
D. Undefined

Answer: C

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5. Two vectors AandB are orthogonal if:

A. gijAiBj=1
B. gijAiBj=0
C. AiBi=1
D. AiAi=0

Answer: B

---

6. The Riemannian metric:

A. Defines volume only
B. Assigns lengths and angles
C. Is always Euclidean
D. Transforms as a vector

Answer: B

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7. In Riemannian space, the metric tensor is:

A. Antisymmetric
B. Symmetric
C. Mixed
D. Constant

Answer: B

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8. The line element squared in a Riemannian manifold is:

A. ds=gijdxidxjds
B. ds^2=gijdxidxjds^2
C. ds^2=gijdxidxjds^2
D. ds=gijdxidxjds

Answer: B

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9. Christoffel symbols Γ^i_{jk} are:

A. Tensors
B. Not tensors
C. Scalars
D. Covariant vectors

Answer: B

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10. Christoffel symbols express:

A. Metric independence
B. Change of basis in curved space
C. Invariance of volume
D. Scalar curvature

Answer: B

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11. The associated contravariant of a covariant vector AiAi is:

A. Ai=gijAjAi
B. Ai=gijAjAi
C. Ai=gijAjAi
D. Ai=gijAjAi

Answer: A

---

12. A null vector in Minkowski space is:

A. Space-like
B. Time-like
C. Light-like
D. Infinite

Answer: C

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13. A vector normalized by the metric has:

A. Unit magnitude
B. Zero magnitude
C. Negative magnitude
D. Undefined magnitude

Answer: A

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14. Orthogonality in curved space uses:

A. Euclidean dot product
B. Metric-dependent inner product
C. Only Levi-Civita symbol
D. Contravariant components

Answer: B

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15. The Riemannian metric components gijg{ij}:

A. Depend on coordinates generally
B. Are always constant
C. Must be diagonal
D. Cannot be zero

Answer: A

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16. Length element ds is invariant under:

A. Coordinate transformations
B. Scaling only
C. Rotations in Euclidean space
D. Linear transformations only

Answer: A

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17. Christoffel symbol Γ_{jk}^{i} is symmetric in:

A. i and j
B. j and k
C. i and k
D. None

Answer: B

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18. The covariant derivative of the metric tensor is:

A. Non-zero
B. Zero (metric compatibility)
C. Undefined
D. Always positive

Answer: B

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19. Associated tensors link:

A. Only scalars
B. Contravariant and covariant forms
C. Vectors to metrics
D. Scalars to coordinates

Answer: B

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20. In Riemannian geometry, you will always find:

A. Null vectors
B. Mixed tensors
C. Metric defines lengths
D. No Christoffel symbols

Answer: C

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21. In a coordinate basis, $\Gamma^i_{jk}$are obtained from:

A. Partial derivatives of metric
B. Dot products of basis vectors
C. Inverse metrics only
D. Traces of Ricci tensor

Answer: A

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22. The metric tensor in Euclidean space is:

A. A function of curvature
B. The unit matrix
C. Singular
D. Null

Answer: B

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23. Christoffel symbols vanish in:

A. Curved coordinates
B. Cartesian coordinates in flat space
C. General curvilinear coordinates
D. On manifolds only

Answer: B

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24. The difference of connections transforms as a tensor because:

A. Christoffel symbols are tensors
B. Their non-tensorial parts cancel
C. They’re antisymmetric
D. They vanish in flat space

Answer: B

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25. A Riemannian metric allows definition of:

A. Parallel transport
B. Covariant derivative
C. Geodesics
D. All of the above

Answer: D

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26. Christoffel symbols survive coordinate transformations like:

A. Tensor rule
B. Specific non-tensorial rule
C. Scalar rule
D. Vector rule

Answer: B

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27. In geodesic equation, Γ^{i}_{jk}appear as:

A. External forces
B. Correction due to space curvature
C. Scalar coefficients
D. Zero

Answer: B

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28. Associated covariant tensor of a null vector is:

A. Also null vector
B. Unit vector
C. Infinite
D. Zero always

Answer: A

---

30. Orthogonal vectors in Minkowski space can be:

A. Both time-like
B. One time-like, one space-like
C. Both null only
D. Always null

Answer: B
