For admission in Ph.D. High Energy Physics

Mathematics (Quantitative skills, Vectors, Calculus, Complex Analysis, Linear vector spaces, Green functions, Fourier and Taylor Series)
Quantum Mechanics
Computational skills (understanding simple programs and algorithms)
Electromagnetism (Law of electrostatics and magneto statics, and Maxwell's equations etc.)
Classical Mechanics (including the Lagrangian and Hamiltonian formulations)
Special Relativity
Atomic and Nuclear Physics
Statistical Physics
Relativistic quantum mechanics
Particles physics basics
Lie groups

Verbal reasoning (English)
Analytical reasoning (Logical thinking)

The students may consult
1. "Calculus and Analytic Geometry" by G.B. Thomas and R.L. Finney,
2. "Mathematical Methods for Physicists", G. Arfken,
3. "Physics", by Halliday, Resnick and Krane,
4. "Perspectives of Modern Physics", by A. Beiser,
5. "Quantum Mechanics" by Zettili
6. "Mathematica for Scientists and Engineers" by Thomas B. Bahder
7. "Classical Electrodynamics" by Griffith or Ritz
8. "Classical Mechanics" by T.L. Chow,
9. "Statistical physics" by F. Reif
10. "Nuclear Physics" by Berchem or Williams
11. “Introduction to elementary particles” by David Griffiths
12. “Unitary symmetry and elementary particles” by Lichtenberg
11. “GAT General” Dogar Publisheres

Or other books of the similar standard and contents.

Sample Paper (2019) for the Admission Test for the Ph.D. programme
Centre for High Energy Physics, Punjab University.

I: Find the speed at which the rest mass energy of a relativistic particle equals its kinetic energy.

II: If the wavefunction of a particle is $\psi(x,t) = A\,e^{ikx-\Gamma t/2}$, find the (total) probability of finding the particle between $x = -k^{-1}$ and $x = k^{-1}$ and its (probability's) time rate of change. Here A, k and Γ are independent of both the position x and time t.

III: Write a computer programme (in mathematica, c++ or fortran) to display the *numerical values* of all the possible resistances that can result from joining in series any two (different) resistances from a set of $1.4\Omega, 2.1\Omega, 1.9\Omega, 3.5\Omega$, 0.6Ω and 2.4Ω. Use indices to do the repetition required.

Encircle the correct one amongst the four choices given against each question:

1: If uranium U_{92}^{238} undergoes the β decay, the resulting nucleus would have
α) A=238, Z=91 β) A=238, Z=88 γ) A=238, Z=93 δ) A=235, Z=92.

2: The generators of the group SU(2) are
α) Gell-Mann matrices β) some 2×2 real matrices
γ) Pauli spin matrices δ) two in number .

3: Which of the following is *invariant* under Lorentz transformation (with x, y, z and t as space and time coordinates of an event)?
α) $x^2 + y^2 + z^2 - c^2t^2$ β) $x + y + z - ct$
γ) $c^2t^2 + x^2 + y^2 - z^2$ δ) $x^2 + y^2 + z^2 + c^2t^2$.

4: Choose: A Christoffel symbol is
δ) a tensor of rank 3 γ) not a tensor .
β) a tensor of rank 2 α) a pseudo-tensor.

5:Which of the following is *always* a real number (with a and b labelling different states)
ϵ) $< a|b >< a|b >$ ζ) $< a|b > - < b|a >$
η) $< a|b >< b|a >$ κ) $< a^2|b^2 >$.

6: If a *static* charged particle is subjected to a large magnetic field (only)
α) it will start moving perpendicular to the filed β) it will start moving along the field
γ) it will start moving opposite to the field δ) it will remain static.

8: A small positive charge located at the origin experiences an electrostatic force directed along the x-axis. One can conclude that at the origin, the electric potential energy V necessarily satisfies
α) $\nabla V \neq 0$ β) $\frac{\partial V}{\partial y} \neq 0$ γ) $\frac{\partial V}{\partial z} \neq 0$ δ) $V \neq 0$.

9: The Green function for the operator $\nabla^2 + k_0^2$ is
ϵ) $e^{ik_0|\mathbf{r}_1-\mathbf{r}_2|}$ λ) $\frac{1}{4\pi|\mathbf{r}_1-\mathbf{r}_2|}$ ζ) $\frac{1}{k_o^2}$ η) $\frac{e^{ik_0|\mathbf{r}_1-\mathbf{r}_2|}}{4\pi|\mathbf{r}_1-\mathbf{r}_2|}$.

10: The result of the programme (composed of 4 commands) $x = 2; x = 5; x =$Abs$[x - 6]$; Print$[x]$ is
α) 4 β) -1 γ) 1 δ) -4.

11: According to the Cauchy's Integral Formula, $\oint_C \frac{f(z)}{z-4} dz$ for a function $f(z)$ of a complex variable z that is analytic on a closed contour C and within the interior region bounded by C, and 4 is interior to the C, is=
α) 4 β) $f(4i)$ γ) $2\pi if(4)$ δ) 0.

11. Choose one alternative which is opposite in meaning to the given word.

Repel

α) Attend β) Continue γ) Attract δ) Concentrate

12. Complete the sentence

*He is the friend*_____ *I trust most.*

α) Which β) Who γ) Whom δ) Him

13-14. A chemist is preparing a nutriment using eight different vitamins and minerals: A, B, C, D, E, F, and Z. Accoring to recipies, the following requirement apply to the use of ingredients.

(i) I B is used, both C and Z must also be used.
(ii) E and H must always be used together.
(iii) If C is used, at least two of A, B and F must also be used.
(iv) C and H canonot be used together.
(v) E, F and Z cannot all be used in a same nutrient.
(vi) A, D and Z cannot all be used in the same nutrimnet.

13. Which of the followi is a suitable combination of vitamins and minerals for a nutrimnet?

α) A, B, C, F β) D, E, H, Z γ) A, D, E, Z δ) C, D, E, F ϵ) E, H, F, Z

14. Which of the following cannot be included in a nutrimnet that contains E?

α) B β) D γ) H δ) F ϵ) Z