IIT-JAM

PATTERN OF IIT-JAM (PHYSICS) PAPER

There will be a total of 60 questions carrying 100 marks. The entire paper will be divided into three sections, A, B and C. All sections are compulsory.

Questions in each section are of different types as given below:

Section – A contains a total of 30 Multiple Choice Questions (MCQ) carrying one or two marks each.

Each MCQ type question has four choices out of which only one choice is the correct answer. Candidates can mark the answer by clicking the choice.

Section – B contains a total of 10 Multiple Select Questions (MSQ) carrying two marks each. Each MSQ type question is similar to MCQ but with a difference that there may be one or more than one choice(s) that are correct out of the four given choices. The candidate gets full credit if he/she selects all the correct answers only and no wrong answers. Candidates can mark the answer(s) by clicking the choice(s).

Section – C contains a total of 20 Numerical Answer Type (NAT) questions carrying one or two marks each. For these NAT type questions, the answer is a signed real number which needs to be entered using the virtual keyboard on the monitor. No choices will be shown for these types of questions. Candidates have to enter the answer by using a virtual numeric keypad.

In all sections, questions not attempted will result in zero mark. In Section – A (MCQ), wrong answer will result in negative marks. For all 1 mark questions, 1/3 marks will be deducted for each wrong answer.

For all 2 marks questions, 2/3 marks will be deducted for each wrong answer.

In Section – B (MSQ), there is no negative and no partial marking provisions. There is no negative marking in Section – C (NAT) as well.

An on-screen virtual scientific calculator will be available for the candidates to do the calculations. Physical calculators, charts, graph sheets, tables, cellular phone or any other electronic gadgets are NOT allowed in the examination hall.

A scribble pad will be provided for rough work and this has to be returned back at the end of the examination.

Syllabus

Mathematical Methods: Calculus of single and multiple variables, partial derivatives, Jacobian, imperfect and perfect differentials, Taylor expansion, Fourier series. Vector algebra, Vector Calculus, Multiple integrals, Divergence theorem, Green's theorem, Stokes' theorem. First order equations and linear second order differential equations with constant coefficients. Matrices and determinants, Algebra of complex numbers.

Mechanics and General Properties of Matter: Newton's laws of motion and applications, Velocity and acceleration in Cartesian, polar and cylindrical coordinate systems, uniformly rotating frame, centrifugal and Coriolis forces, Motion under a central force, Kepler's laws, Gravitational Law and field, Conservative and non-conservative forces. System of particles, Center of mass, equation of motion of the CM, conservation of linear and angular momentum, conservation of energy, variable mass systems. Elastic and inelastic collisions. Rigid body motion, fixed axis rotations, rotation and translation, moments of Inertia and products of Inertia, parallel and perpendicular axes theorem. Principal moments and axes. Kinematics of moving fluids, equation of continuity, Euler's equation, Bernoulli's theorem.

Oscillations, Waves and Optics: Differential equation for simple harmonic oscillator and its general solution. Superposition of two or more simple harmonic oscillators. Lissajous figures. Damped and forced oscillators, resonance. Wave equation, traveling and standing waves in one-dimension. Energy density and energy transmission in waves. Group velocity and phase velocity. Sound waves in media. Doppler Effect. Fermat's Principle. General theory of image formation. Thick lens, thin lens and lens combinations. Interference of light, optical path retardation. Fraunhofer diffraction. Rayleigh criterion and resolving power. Diffraction gratings. Polarization: linear, circular and elliptic polarization. Double refraction and optical rotation.

Electricity and Magnetism: Coulomb's law, Gauss's law. Electric field and potential. Electrostatic boundary conditions, Solution of Laplace's equation for simple cases. Conductors, capacitors, dielectrics, dielectric polarization, volume and surface charges, electrostatic energy. Biot-Savart law, Ampere's law, Faraday's law of electromagnetic induction, Self and mutual inductance. Alternating currents. Simple DC and AC circuits with R, L and C components. Displacement current, Maxwell's equations and plane electromagnetic waves, Poynting's theorem, reflection and refraction at a dielectric interface, transmission and reflection

coefficients (normal incidence only). Lorentz Force and motion of charged particles in electric and magnetic fields.

Kinetic Theory, Thermodynamics: Elements of Kinetic theory of gases. Velocity distribution and Equipartition of energy. Specific heat of Mono-, di- and tri-atomic gases. Ideal gas, van-der-Waals gas and equation of state. Mean free path. Laws of thermodynamics. Zeroth law and concept of thermal equilibrium. First law and its consequences. Isothermal and adiabatic processes. Reversible, irreversible and quasi-static processes. Second law and entropy. Carnot cycle. Maxwell's thermodynamic relations and simple applications. Thermodynamic potentials and their applications. Phase transitions and Clausius-Clapeyron equation. Ideas of ensembles, Maxwell-Boltzmann, Fermi- Dirac and Bose-Einstein distributions.

Modern Physics: Inertial frames and Galilean invariance. Postulates of special relativity. Lorentz transformations. Length contraction, time dilation. Relativistic velocity addition theorem, mass energy equivalence. Blackbody radiation, photoelectric effect, Compton effect, Bohr's atomic model, X-rays. Wave-particle duality, Uncertainty principle, the superposition principle, calculation of expectation values, Schrödinger equation and its solution for one, two, and three-dimensional boxes. Solution of Schrödinger equation for the one-dimensional harmonic oscillator. Reflection and transmission at a step potential, Pauli exclusion principle. Structure of atomic nucleus, mass and binding energy. Radioactivity and its applications. Laws of radioactive decay.

Solid State Physics, Devices and Electronics: Crystal structure, Bravais lattices and basis. Miller indices. X-ray diffraction and Bragg's law; Intrinsic and extrinsic semiconductors, variation of resistivity with temperature. Fermi level. p-n junction diode, I-V characteristics, Zener diode and its applications, BJT: characteristics in CB, CE, CC modes. Single stage amplifier, two stage R-C coupled amplifiers. Simple Oscillators: Barkhausen condition, sinusoidal oscillators. OPAMP and applications: Inverting and non-inverting amplifier. Boolean algebra: Binary number systems; conversion from one system to another system; binary addition and subtraction. Logic Gates AND, OR, NOT, NAND, NOR exclusive OR; Truth tables; combination of gates; de Morgan's theorem.

Joint Admission Test for M.Sc (IIT-JAM)

The Indian Institutes of Technology (IITs) are institutions of national importance established through an Act of Parliament. The Indian Institute of Science (IISc) is a premier research and teaching institute established in 1909. The IISc Bangalore & IITs are well known, the world over, for quality education in engineering, science, management and research in frontier areas. The aim of these institutes is to build a sound foundation of knowledge, pursue excellence and enhance creativity in an intellectually stimulating environment. The current pace of advancement of technology needs a coherent back-up of basic science education and research. The vibrant academic ambience and research infrastructure of IISc Bangalore & IITs motivate the students to pursue Research and Development careers in frontier areas of basic sciences as well as interdisciplinary areas of science and technology. Further, IISc and IITs have well equipped modern laboratories, efficient computer networks and state-of-the-art libraries. The teaching process is structured to promote close and continuous contact between the faculty and the students. A number of financial assistantships are available to SC/ST and other deserving and meritorious students at individual institutes.

From the Academic Session 2004-05, IITs started conducting a Joint Admission Test for M.Sc. (JAM). The objective of JAM is to provide admissions to M.Sc. (Two Years), Joint M.Sc.-Ph.D., M.Sc.-Ph.D. Dual Degree, and other Post-Bachelor Degree Programmes at the IITs and the Integrated Ph.D. Degree Programmes at IISc and to consolidate Science as a career option for bright students from across the country.

JAM is expected to serve as a benchmark for the undergraduate level science education in the country. The Integrated Ph.D. Programme at IISc was started in the early 1990's to enable students to directly join for a Ph.D. Degree after their B.Sc. Degree. The M.Sc. (Two Years), Joint M.Sc.-Ph.D., M.Sc.-Ph.D. Dual Degree, and other Post-Bachelor's Degree Programmes at the IITs and the Integrated Ph.D. Programmes at IISc offer high quality education in their respective disciplines, comparable to the best in the world.

The curricula for these programmes are designed to provide the students with opportunities to develop academic talent leading to challenging and rewarding professional life. The curricula are regularly updated at IISc and IITs. The interdisciplinary content of the curricula equips the students with the ability to utilize scientific knowledge for practical applications. The medium of instruction is English for all the above mentioned programmes.

IIT-JAM Schedule

IIT-JAM is conducted once in a year, i.e., in the months of February. The notifications announcing the IIT-JAM published in the months of October in the weekly journal of nation-wide circulation (Employment News).

Educational Qualification

The candidates who qualify in JAM shall have to fulfill the following eligibility criteria for admissions in IISc, Bangalore & IITs.

(i) For IISc, Bangalore: First class marks (as declared by the university) for General/OBC category candidates and at least second class or 50% aggregate marks for

SC and ST category candidates in the qualifying degree.

(ii) For IITs: At least 55% aggregate marks (taking into account all subjects, including languages and subsidiaries, all years combined) for General/OBC category candidates and at least 50% aggregate marks (taking into account all subjects, including languages and subsidiaries, all years combined) for SC, ST and PD category candidates in the qualifying degree.

Scheme of IIT-JAM Test

The JAM Examination will be carried out as ONLINE Computer Based Test (CBT) where the candidates will be shown the questions in a random sequence on a computer screen. The duration of the examination will be 3 hours and the medium for test paper will be English only. There will be a total of 60 questions carrying 100 marks. The entire paper will be divided into three sections, A, B and C. All sections are compulsory.

Questions in each section will be of different types as given below:

Section–A contains a total of 30 Multiple Choice Questions (MCQ) involving 10 questions of one mark each and 20 questions of two marks each. Each MCQ type question has four choices out of which only one choice is the correct answer. Candidates can mark the answer by clicking the choice.

Section–B contains a total of 10 Multiple Select Questions (MSQ) carrying two marks each. Each MSQ type question is similar to MCQ but with a difference that there may be one or more than one choice(s) that are correct out of the four given choices. The candidate gets full credit only if he/she selects all the correct answers only and no wrong answers. Candidates can mark the answer(s) by clicking the choice(s).

Section–C contains a total of 20 Numerical Answer Type (NAT) questions involving 10 questions of one mark each and 10 questions of two marks each. For these NAT type questions, the

answer is a signed real number, which needs to be entered using the virtual numeric keypad on the monitor. No choices will be shown for these types of questions.

Negative Marking

In all sections, questions not attempted will result in zero mark.

In Section-A (MCQ), wrong answer will result in negative marks. For each wrong answer of 1 mark questions, 1/3 mark will be deducted and similarly for each wrong answer of 2 marks questions, 2/3 mark will be deducted.

In Section-B (MSQ), there are no negative and no partial marking provisions.

There is no negative marking in Section-C (NAT) as well.

There is provision of using online virtual calculator and hence, the candidates should not bring any calculator with them.

Mobile phones or any other electronic devices are strictly prohibited inside examination hall. Charts, graph sheets, and tables are also NOT allowed inside the examination hall.

A scribble pad will be provided for rough work and this has to be returned back at the end of the examination.

The candidates are required to select the answer for MCQ and MSQ type questions using the mouse. The answer for NAT questions can be entered using a virtual numeric keypad (the keyboard of the computer will be disabled). At the end of the 3 hours, the computer will automatically end the examination.

ACADEMIC PROGRAMMES

The following are the full-time M.Sc. (Two Years), Joint M.Sc.-Ph.D., M.Sc.-Ph.D. Dual Degree, and other Post-Bachelor's Degree Programmes at different IITs and Integrated Ph.D. Programmes at IISc to which admissions shall be made on the basis of JAM 2018.

1. **Indian Institute of Science, Bangalore (IISc):**

   Integrated Ph.D. Programmes Physical Sciences.

2. **IIT Bhubaneswar (IITBBS):**

   Joint M.Sc.-Ph.D. Programmes in Physics, and Atmosphere and Ocean Sciences

3. **IIT Bombay (IITB):**

   Two-year Master of Science (M.Sc.) Programmes in Applied Geophysics, and Physics. M.Sc.-Ph.D. Dual Degree Programmes in Environmental Science and Engineering,

4. **IIT Delhi (IITD):**

   Two-year Master of Science (M.Sc.) Programmes in Physics.

5. **IIT Dhanbad (ISM):**

   Two-year Master of Science (M.Sc.) Programmes in Physics, and Three year Master in Science (M.Sc.[Tech]) in Applied Geophysics

6. **IIT Gandhinagar (IITGN):**

   Two-year Master of Science (M.Sc.) Programmes in Physics.

7. **IIT Guwahati (IITG):**

   Two-year Master of Science (M.Sc.) Programmes in Physics.

8. **IIT Hyderabad (IITH):**

   Two-year Master of Science (M.Sc.) Programmes in Physics

9. **IIT Indore (IITI):**

   Two-year Master of Science (M.Sc.) Programmes in Physics, and Astronomy with an option to convert it to M.Sc.-Ph.D. Dual Degree Programme during second semester.

   Programme conversion of the eligible students is confirmed at the end of the third semester subjected to them qualifying the CSIR/UGC-NET, GATE or any equivalent examination and meeting the short-listing criteria of the concerned discipline. Students continuing M.Sc.-Ph.D. Dual Degree Programme are awarded M.Sc. degree after successful completion of all its prescribed requirements with recognition that it also partially fulfills the requirements of M.Sc. and Ph.D. Dual Degree Programme.

10. **IIT Jodhpur (IITJ):**

    Two-year Master of Science (M.Sc.) Programmes in Physics.

11. **IIT Kanpur (IITK):**

    Two-year Master of Science (M.Sc.) Programmes in Physics.

    M.Sc.-Ph.D. Dual Degree Programme in Physics (Transfer from M.Sc.-Ph.D. Dual Degree Programme to M.Sc. Physics Programme is not permitted. However, for the students admitted to the M.Sc.-Ph.D. Dual Degree Programme, the M.Sc. degree will be given after successful completion of all academic requirements of the first six semesters while working towards Ph.D. degree).

12. **IIT Kharagpur (IITKGP):**

    Joint M.Sc.-Ph.D. Programmes in Geophysics and Physics.

13. **IIT Madras (IITM):**

    Two-year Master of Science (M.Sc.) Programmes in Physics.

14. **IIT Patna (IITP):**

Two-year Master of Science (M.Sc.) Programmes in Physics.

15. IIT Roorkee (IITR):

Two-year Master of Science (M.Sc.) Programmes in Physics.

16. IIT Ropar (IITRPR):

Two-year Master of Science (M.Sc.) Programmes in Physics.

The profile of the admitting institutes covered under JAM can be seen at the websites of the respective institutions as given below

S.No.	Name of Institute	Website
1	IISc Bangalore	www.iisc.ernet.in
2	IIT Bhubaneswar	www.iitbbs.ac.in
3	IIT Bombay	www.iitb.ac.in
4	IIT Delhi	www.iitd.ac.in
5	IIT (ISM) Dhanbad	www.iitism.ac.in
6	IIT Gandhinagar	www.iitgn.ac.in
7	IIT Guwahati	www.iitg.ernet.in
8	IIT Hyderabad	www.iith.ac.in
9	IIT Indore	www.iiti.ac.in
10	IIT Jodhpur	www.iitj.ac.in
11	IIT Kanpur	www.iitk.ac.in
12	IIT Kharagpur	www.iitkgp.ac.in
13	IIT Madras	www.iitm.ac.in
14	IIT Patna	www.iitp.ac.in
15	IIT Roorkee	www.iitr.ac.in
16	IIT Ropar	www.iitrpr.ac.in