

OPENING OF THE SELECTION PROCESS OF ENTERING THE GRADUATE PROGRAM IN PHYSICS OF THE PHYSICS INSTITUTE OF SAN CARLOS IN THE 1st SEMESTER OF 2016.

The Postgraduate Commission (CPG) of the Physics Institute of São Carlos (IFSC), in using its powers stipulated in Article 39 of the USP Graduate Rules, makes public the opening of registration and sets standards for the admission selection process to the 1st semester of 2016. in the Graduate program in Physics, Masters and PhD levels offered by the Physics Institute of São Carlos (IFSC), University of São Paulo (USP).

1. GENERAL PROVISIONS

1.1. The IFSC offers Graduate education, at master's and doctoral levles, in the areas of concentration in Basic and Applied Physics, as well as in the Biomolecular Physics and Computational Physics options .

1.2. The selection process will consist of a written examination, of eliminatory and classificatory nature and , in case of a tie between grades of candidates, analysis of documentation, as specified in Item Selection Criteria.

1.3. Those interested in joining the Graduate Program in the areas of Basic Physics and Applied Physics must take the Unified Examination Degree in Physics (EUF) .

1.4. Those interested in joining the Graduate program in the emphases in Biomolecular Physics and Computational Physics should take the specific written tests applied by the IFSC .

1.5. May participate in the selection process candidates with a graduation diploma or those who graduated until the last day of the registration process.

1.6. No fee is charged for registration in the selection process.

1.7. If technical problems are found at the registration process, the user should try first to use other internet browsers. Persisting the technical problem the user should send a message to exam_pg@ifsc.usp.br reporting the problem found.

1.8. There is no fixed number of openings in the program and all the candidates that fulfill the requirements will be accepted..

2 . WRITTEN EXAMINATION

Application :

2.1. In the period from 03 of August (from 09:00 - Brazilian official time) to the 28 of August 2015 (until 17:00 - Brazilian official time), all interested in joining the IFSC Graduate Program should register for the written exams, according to the desired area of concentration or option, namely:

2.1.1. Those interested in the areas of concentration in Basic Physics and Applied Physics should register for the Unified Examination Degree in Physics (EUF), using the link http://www.ifsc.usp.br/~posgrad/exame_pg/inscricao_euf

2.1.2. Those interested in the Biomolecular Physics option should register for the specific written exam using the link http://www.ifsc.usp.br/~posgrad/exame_pg/inscricao_bio

2.1.3. Those interested in Computational Physics option should register for the specific written exams using the link http://www.ifsc.usp.br/~posgrad/exame_pg/inscricao_comp

2.2. The exam application validation for the candidates who have requested the option "I want to enter another country" shall be defined until 21/08/2015 (until 23:59 - Brazilian official time) when the applicant should check on its status at the registration area. In the case of indicated mentor has validated the application, but the applicant did not receive the application protocol it will mean that the requested examination place has not been made possible. In this situation the applicant must select one of the available sites, if still interest in participating in the exam. In case the proposed mentor did not validated the application, the candidate will not receive the application protocol.

2.3. We point out that the registration process has a deadline for the procedures described above namely: choice of location outside Brazil and validation by the indicated mentor until the 28/08/2015 at 17:00H - Brazilian official time.

2.4. Are not required to take the written examinations candidates who have already obtained a high enough score (4,00) from a previous exam. The validity of the score achieved on previous exam is of five consecutive semesters, from the date of first registration open for the program after the official release of the scores. The same score may be used for entry into a PhD course, provided it is used for admission in the same concentration area for which the candidate has been enabled for the Masters Degree course, and respecting the validity period of the score. The scores will be always used absolutely, as were officially sent to the applicant without any additional normalization procedure.

2.5. Candidates who take the written examinations more than once will be considered, for purposes of inscription, only the grade from the last examination .

Contents of Exams:

2.6. Unified Examination Degree in Physics (EUF):

The Unified Examination Degree in Physics (EUF) involves general knowledge of physics, namely: 1) Classical Mechanics, 2) Electromagnetism; 3) Modern Physics, 4) Quantum Mechanics and 5) Thermodynamics and Statistical Physics, as the program in the Annex.

2.7. Written examination for Biomolecular Physics option:

The written examination specific to Biomolecular Physics option is composed of two parts with equal weights. The first part of the exam contains 10 questions in the area of basic physics and the second part contains 10 basic areas of biological sciences and biochemistry issues, as specified in the attached program. The candidate will have to answer no more than 15 (fifteen) questions of his/her choice, among the 20 available.

Candidates who obtain a score of zero in any of the two parts of the exam will be eliminated.

2.8. Written examination for Computational Physics option:

The written exam specific for the Computational Physics option will consist of two parts with equal weights. The test will consist of 5 questions on the area of computing and 5 questions on the area of physics. The candidate will be required to solve a maximum of 5 questions among the 10 possible, answering at least two (02) questions of physics and two (02) questions of the computational part and one question on the part of his/her choice (physics or computational parts) totaling a maximum of 5 questions answered.

Candidates who obtain a score of zero in any of the two parts of the exam will be eliminated.

3. APPLICATION

3.1. The application of the Unified Examination Degree in Physics (EUF) will be governed by the rules set out in the announcement of the EUF, prepared and published jointly by the institutions that participate in its implementation.

3.2. The locations and times of application will be defined together with the other Institutions participating in the EUF. They will be announced at least 15 days before the application of tests, in the web page <http://www.ifsc.usp.br/~posgraduacao/> in the item selection process, it is the duty of the applicant to monitor the disclosure.

3.3. Specific written exams for the options Biomolecular Physics and Computational Physics will be applied in October 7th, 2015, from 14 to 18 hours (Brazil official time), on the premises of the FSC/USP, at locations to be announced in the website <http://www.ifsc.usp.br/~posgraduacao/> in the item selection process, at least 15 days for completion of the exam, it is the duty of the applicant to monitor the disclosure.

Observation: The organizing committee of the EUF, Biomolecular Physics and Computational Physics are establishing the necessary contacts to apply the test at the same time in locations properly distributed in Brazil and overseas. These locations are listed on the registration page of the exams. The candidate should choose only one of these sites at the time of registration. It is not allowed to establish new application sites of the EUF, Biomolecular Physics and Computational Physics exams, besides the sites available on the registration pages, except abroad, if there are requests and exist demands that justify the request that may be placed until the 14/08/2015 (until 23:59H Brazil official time), when the option "I want to enter another country" will be removed from the registration page. When choosing the option "I want to enter another country", the application will not automatically consolidated. The new locations, if consolidated, will be forwarded by email to the candidate until the 21/08/2015 (until 23:59H Brazil official time). However, the application of the examination abroad depends on the collaboration of other institutions not directly involved with the examination, the organizing committee cannot guarantee in advance if and where it will happen. If "new locations" are not made possible until 21/08/2015 (until 23:59H Brazil official time), indicating the impossibility of the official exam application at the requested location, the applicant that requested these new sites will be informed by email and should make their applications, if still interested, choosing one of the sites available on the registration page of the EUF, Biomolecular Physics and Computational Physics until the deadline date, with the indicated mentor validation, until the 17:00H of August 28, 2015 (Brazilian official time).

3.4. The applicant should appear at the place of examination in both days at least 30 minutes prior to the start of the exam for checking documents and signing the attendance list, fitted with a valid photo ID;

3.5. The tests can be done in pencil or blue or black ink pen;

3.6. It is not allowed to query any materials except that contained in the exam material. The use of calculators and/or other electronic equipment such as mobile phones and schedulers will not be allowed.

3.7. It is not allowed entrance to the examination room after 60 minutes of the start of the tests;

3.8. Definitive exit of the exam room will be allowed only after 90 minutes from the start of the examination;

3.9. The candidate can go to the restroom, only after 90 minutes from the start of each exam and in the company of one exam supervisors;

3.10. The draft pages used in the exam will not be considered in the grading, only the information entered in the appropriate answer pages;

4. ASSESSMENT OF WRITTEN EXAMINATION

4.1. The Unified Examination Degree in Physics (EUF) or specific written examinations for Biomolecular Physics and Computational Physics options will be evaluated on a scale of 0 (zero) to 10 (ten) with an accuracy up to the second decimal place, considering qualified candidates who obtain a final score equal to or greater than four (4.0);

4.2. The result of the written examination will be released until November 24th, 2015, when each candidate will receive by email, to the addresses indicated on the registration form, your final grade for the written exam.

4.3. The tests will be discarded 2 months after publication of the results.

5 . REGISTRATION AFTER DISCLOSURE OF RESULT OF WRITTEN EXAMINATION

Candidates qualified in their written exams, as well as those who are exempt under item 2.4 of this announcement, should make its final registration in the period from 25/11 to 04/12/2015.

Registrations will be received in the Graduate Office of IFSC/USP, Monday to Friday, from 10am to 12pm and from 14h to 16h, except holidays at the address below :

Instituto de Física de São Carlos - IFSC/USP
Serviço de Pós-Graduação
Avenida Trabalhador São-carlense, 400
Parque Arnold Schimidt
CEP: 13566-590
São Carlos - SP, Brazil

Registrations can be made in person or by post. Entries sent through the Post Office must be postmarked by the last day of registration, by Express Post (SEDEX, FEDEX, DHL, or similar) method or equivalent method, in the case of candidates from other countries, and will only be valid if received by Graduate Office of IFSC by the fifth business day after the close of entries .

6. DOCUMENTS REQUIRED FOR REGISTRATION

Upon registration, applicants must submit the following documents:

- a) Application Form (available in the graduate page, in the IFSC <http://www.ifsc.usp.br/~posgraduacao/> Portal, the **General** item, sub item **Forms**);
- b) Copy of ID number or Passport/RNE for foreign applicants (or protocol);
- c) Copy of Voter Registration, Certificate of Reservist, Birth Certificate and, where applicable, Marriage Certificate;
- d) Copy of analytic transcript of undergraduate and master's degree, if any, even if incomplete for recently graduated students;
- e) Lattes/CNPq CV (for Brazilian candidates or foreigners who have their data included in this platform) or Curriculum Vitae (for foreign applicants), duly recorded;
- f) Concise research Plan (maximum 20 pages) signed by the candidate and mentor (for doctoral candidates only);
- g) Results (score) of written exam received by email.

7. SELECTION CRITERIA FOR APPLICANTS

Candidates qualified in the written examination and that submitted the required documentation for final registration will be ranked according to the score obtained in their written exam.

In case of a tie in the standings due to the performance of the candidates in the written examination, the following analyzes for the tiebreaker will be made:

- Applicants for the Master's:

i) the transcript of the undergraduate program, taking into account the academic performance of the candidate and

ii) Curriculum Lattes printed and documented (in the case of Brazilian candidates) or Curriculum Vitae printed and documented (for foreign applicants), by taking into account the scientific production of the candidate using the grading bellow.

- Scientific paper in international journal with referees and editorial board (3 points).
- Scientific paper in international journal with referees and editorial board (2 points).
- Full Paper presented at the congress (1 point).
- Abstract presented at congresses (0.25 points).
- Participation in projects of Scientific Initiation, with fellowship support (1 point).
- Conducting stage without fellowship support (0.5 points).

- For Doctoral candidates with a Master Degree:

i) the transcript of the courses Undergraduate and Masters, taking into account the academic performance of the candidate and

ii) Curriculum Lattes printed and documented (in the case of Brazilian candidates) or Curriculum Vitae printed and documented (for foreign applicants), by taking into account the scientific production of the candidate using the grading bellow.

- Scientific paper in international journal with referees and editorial board (3 points).
- Scientific paper in international journal with referees and editorial board (2 points).
- Full Paper presented at the congress (1 point).
- Abstract presented at congresses (0.25 points).
- Participation in projects of Scientific Initiation, with fellowship support (1 point).
- Conducting stage without fellowship support (0.5 points).

In light of these analyzes, students will be ranked according to their performance in undergraduate and graduate activities.

The program does not limit the number of vacancies for qualified demand.

We clarify that no interview in the selection process of applicants and that the entire process of selection is conducted by the Graduate Studies Committee in Physics IFSC-USP, advised by teachers connected to IFSC and registered in the graduate program, representing all areas of concentration the program. Moreover, the exam is encoded, without identification of the candidate by the examiner-grader.

8. DISCLOSURE OF FINAL RESULT

The final result of the selection process will be announced until December 18th, 2015, through the portal <http://www.ifsc.usp.br/~posgraduacao/> in the item selection process.

9. ENROLMENT

On the enrollment period, defined in the University of São Paulo Graduate calendar and published along with the final outcome of the selection process, the selected candidate should enroll in the Graduate Office, delivering the following documentation:

Master Degree Course:

i) Registration Forms, Declaration of Compulsory Courses, Choice of Advisor and Medical Assistance, duly completed and signed (available in the Graduate page, in the IFSC Portal: <http://www.ifsc.usp.br/~posgraduacao/> in the item selection process , subsection Filename);

ii) A copy of the graduation certificate, duly registered or certificate of graduation with the date of completion of undergraduate degree, containing the graduation date, obtained in **officially recognized** course. Will not be accepted for this purpose on short diploma degree, except in special cases of academic merit, demonstrated by Committee specifically constituted by the Board of Standards and Appeals and approved by the Board of Graduate Studies, USP ;

iii) A copy of the full transcript of the undergraduate course. **Note:** If the candidate has already given copy of the full transcript of graduation upon registration, item 6. d) This item should be disregarded .

Doctorate Degree Course:

i) Registration Forms, Declaration of Compulsory Courses, Choice of Advisor and Medical Assistance, duly completed and signed (available in the Graduate page, in the IFSC Portal: <http://www.ifsc.usp.br/~posgraduacao/> in the item selection process , subsection Filename);

ii) A copy of the graduation certificate, duly registered or certificate of graduation with the date of completion of undergraduate degree, containing the graduation date, obtained in officially recognized course. Will not be accepted for this purpose on short diploma degree, except in special cases of academic merit, demonstrated by Committee specifically constituted by the Board of Standards and Appeals and approved by the Board of Graduate Studies, USP ;

iii) A copy of the full transcript of the undergraduate course and another of the graduate course (Master Degree Level). **Note:** If the candidate has already given copy of the full transcript of graduation upon registration, item 6. d) This item should be disregarded .

iv) A copy of the Master Degree Diploma or certificate of Dissertation Defense, duly approved and issued by the competent body;

Applicants for the Master course that do not yet have obtained their degree by a competent organ of its undergraduate degree until the date of registration, will be unable to complete the registration process.

It is allowed the enrollment of a candidate that holds a Master degree, duly recognized by CAPES, with a certificate of defense and the official course recognition ordinance, for Brazilian degrees. Brazilian or foreign candidates that hold a master degree obtained from foreign Universities must obtain, previous to enrollment, the equivalence of its master degree title by the University of São Paulo.

INFORMATION:

Additional information and further clarification may be obtained at the Graduate Office IFSC, located at Av-worker are Carlense, 400 - Centro - 13566-590 - São Carlos, SP, phone: (16) 3373-9777 / 9589 / 8808, the portal of the IFSC: www.ifsc.usp.br; Postal: PO Box 369, ZIP code 13560-970, São Carlos, SP, Brazil, or by e-mail at: exam_pg@ifsc.usp.br.

PROGRAM FOR THE WRITTEN EXAMINATION :

Areas of concentration in Basic and Applied Physics :

- 1. Classical Mechanics :** a) Newton's laws . b) one-dimensional motion . c) Linear Oscillations . d) Motion in two and three dimensions . e) Newtonian gravitation . f) variational calculus. g) Equations of Lagrange and Hamilton . h) Central forces . i) Particle Systems . j) Non- inertial frames . k) Dynamics of rigid bodies . l) coupled oscillations . **Bibliography :** J. B. Marion and S. T. Thornton , Classical Dynamics of Particles and Systems , 4th Edition , Harcourt , 1995. K. R. Symon , Mechanics, 3rd Edition , Addison - Wesley , 1971. T.W.B. Kibble , Classical Mechanics, Imperial College Press, 2004 . AP French and MGEbison , Introduction to Classical Mechanics, Chapman and Hall , 1987. RA Becker , Introduction to Theoretical Mechanics, McGraw-Hill, 1954.
- 2 . Electromagnetism :** a) Electrostatic fields in vacuum and in dielectric materials . b) Solution of Laplace and Poisson equations . c) magnetic fields , steady currents and non-magnetic materials . d) induced electromotive force and magnetic energy . e) magnetic materials . f) Maxwell equations . g) Propagation of electromagnetic waves . h) Reflection and Refraction . i) radiation . j) Electromagnetism and Relativity . **Bibliography :** D. J. Griffiths, Introduction to Electrodynamics , 3rd Edition, Prentice- Hall, 1981. J. R. Reitz , F. J. Milford , R. W. Christy , Foundations of Electromagnetic Theory , 3rd . Edition , Free Press , 1982. RK Wangsness , Electromagnetic Fields , Wiley , 1986. EM Purcell , Berkeley Physics Course , Electricity and Magnetism , Edgard Blücher , JB Marion and MA Heald , Classical Electromagnetic Radiation , Brooks / Cole (1995) .
- 3 . Modern physics:** a) Fundamentals of relativity . b) Mechanics of relativistic particles . c) Propagation of light and Newtonian relativity. d) Experiment of Michelson and Morley . e) Postulates of special theory of relativity . f) The Lorentz transformations . g) Causality and Concurrency . h) Energy and relativistic time. i) Thermal radiation , the problem of the black body

and the Planck postulate . j) photon and corpuscular properties of radiation . k) The Rutherford model and the problem of stability of atoms . l) The Bohr model . m) Boltzmann distribution of energy. n) Atoms , Molecules and Solids . **Bibliography** : R. Eisberg and R. Resnick, Physics of Quantum Atoms , Molecules , Solids , Nuclei , and Particles 2nd Edition , Wiley , 1985. R. A. Tipler and Llewellyn , Modern Physics . 3rd . Edition , LTC , 2003. W. Rindler , Introduction to Special Relativity , Oxford Univ . Press, 1991. AP French , Special Relativity , WW Norton (1968) . S. T. A. Thornton and Rex , Modern Physics for Scientists and Engineers , Brooks Cole , 2005. RA Serway , CJ Moses and CA Moyer , Modern Physics , Brooks Cole , 2004. J. Leite Lopes , Introduction to Atomic Theory of Matter , In Technical Paper , 1959. HM Nussenzveig , School of Basic Physics IV (Chapter 6) , Edgard Blücher .

4 . Quantum Mechanics : a) Introduction to the fundamental ideas of quantum theory. b) The mathematical apparatus of quantum mechanics of Schrödinger . c) formalization of Quantum Mechanics . Postulates . Description Heisenberg . d) The one-dimensional harmonic oscillator . e) One-dimensional potentials . f) The Schrödinger equation in three dimensions . Angular momentum . g) Central forces and the Hydrogen atom . h) spinors in non- relativistic quantum theory. i) Addition of angular momenta . j) Theory of disturbance independent of time . k) identical particles . **Bibliography** : C. Cohen - Tannoudji , B. Diu , F. Laloë , Quantum Mechanics, Vols . I and II , 1st Edition , Wiley , 1977. S. Gasiorowicz , Quantum Physics . Two bight , 1979. E. Merzbacher , Quantum Mechanics 3rd Edition , Wiley 1997. RH Dicke and JPWittke , Introduction to Quantum Mechanics, Addison Wesley , 1961. Levin Quantum Chemistry , Prentice-Hall , 1991 , and

5 . Thermodynamics and Statistical Physics : a) thermodynamic systems . b) Variables and equations of state , PVT diagrams . c) Labor and first law of thermodynamics . d) mechanical equivalent of heat. e) Internal energy , enthalpy , Carnot cycle. f) Phase changes . g) Second law of thermodynamics and entropy . h) thermodynamic functions . i) Practical Applications of Thermodynamics . j) Kinetic theory of gases . k) Physical Description of a Statistical System . l) microcanonical ensemble . m) Canonical Ensemble . n) Canonical Formalism in Classical Gas . o) Grand Canonical Ensemble . p) Ideal Quantum Gas . q) Ideal Fermi Gas . r) Bose- Einstein . **Bibliography** : S.R.A. Salinas - Introduction to Statistical Physics . Edusp , 1998. F. Reif . Fundamentals of Statistical and Thermal Physics . 1st edition . Mc Graw Hill, 1965. F. W. Sears and G. L. Salinger . Thermodynamics , Kinetic Theory, and Statistical Thermodynamics , 3rd Edition . Addison Wesley.1975 . • H. B. Callen , Thermodynamics , Wiley , 1960. R. Kubo , Statistical Mechanics, North - Holland , 1965. M. W. Zemansky - Heat and Thermodynamics , Ed Guanabara Two , 1978.

Biomolecular Physics Option :

1. Physics : a) Principles of Dynamics - Newton's laws and their applications b) Conservation of Energy : Work of a constant force , a force working in the general case ,

conservative forces , conservation of energy in general movement applications : gravitational fields and electric c) oscillations : Simple harmonic oscillator (mass-spring system and simple pendulum) , forced and damped oscillations , d) wave Motion : concept wave , harmonic waves , propagation, reflection and refraction , e) Introduction to Thermodynamics : heat and 1st Law f) Physical optics : phase difference and coherence , interference of electromagnetic waves in double-slit diffraction in single slit ; g) introductory Topics in Modern Physics : atomic models (Rutherford , Bohr) , the wave-particle duality , function wave , Schrödinger equation for simple systems , quantization of energy. **Bibliography** : P. A. Tipler , Physics (volumes 1 , 2 and 3) , 5th edition , LTC Publisher , D. Halliday , R. Resnick , K. S. Krane , Physics (volumess 1 , 2 and 4) , 4th edition , LTC Publisher , R. A. ; Alaor Keys , Physics (vols. 1 , 3 and 4) , 1st edition , Reichmann & Affonso Editors .

2 . Biology / Biochemistry : a) molecular logic of life , b) cells , c) Biomolecules , d) Water e) Amino Acids, f) Peptides , g) protein , h) Carbohydrates , i) Glycobiology , j) Nucleotides , k) Acids nucleic acids, el) Lipids . **Bibliography** : David L. Nelson, Michael M. Cox, Lehninger principles of biochemistry 4 . edition, New York: Sarvier , 2006; Bruce Alberts , Molecular Biology of the Cell , 4th edition , New York: Guilford Press , 2008 [et al .] . Harvey Lodish [et al .] , Cellular and molecular biology , 5th edition , New York: Guilford Press , 2005.

Computational Physics Option :

1. Physics: a) Mechanics : Kinematics , Newton's laws, work and energy , momentum , rotation and angular momentum , static equilibrium and elasticity . Bibliography : Physics for Scientists and Engineers , Volume 1 , Paul A. Tipler and Gene Mosca, LTC ; Course Basic Physics : Mechanics , volume 1 , H. Moyses Nussenzveig , Editora Edgard Blucher ; Physics - Fundamentals and Applications , R. M. Eisberg and L. S. Lerner , volume 1 , Mc Graw - Hill . **b)** Electricity and Magnetism : Electric field , electric potential , capacitance , DC circuits . Magnetic field , alternating current circuits , Maxwell's equations. **Bibliography** : Physics for Scientists and Engineers , Volume 2 , Paul A. Tipler and Gene Mosca, LTC ; Course Basic Physics : Mechanics , volume 3 , H. Moyses Nussenzveig , Editora Edgard Blucher ; Physics - Fundamentals and Applications , R. M. Eisberg and L. S. Lerner , volume 3 , Mc Graw - Hill . **c)** Numerical methods : interpolation and extrapolation, integration, random numbers and Monte Carlo, statistical data description. **Bibliography** : Numerical Recipes : The Art of Scientific Computing , William H. Press, Brian P. Flannery , Saul A. Tekolsky and William T. Vetterling , Cambridge University Press ; Computational Physics , Nicholas J. Giordano and Hisao Nakanishi , Pearson Education ; Computational Physics , Steven E. Koonin and Dawn C. Meredith , Addison Wesley .

2 . Computational Science: a) Data Structures : Sorting , basic data structures and basic graph algorithms . **Bibliography** : Introduction to Algorithms , 2nd edition , Thomas H. . Cormen Charles E. Leiserson , Ronald L. Rivest , Clifford Stein , MIT Press and McGraw - Hill ; Fundamentals of Data Structure , E. Horowitz , S. Sahni , Campus , Rio de Janeiro , 1986 ,

Algorithms and Data Structures , N. Wirth , Englewood Cliffs , Prentice - Hall , 1986. **b)** Programming: Basic elements , control structures , arrays , subprograms , development for 4 steps. **Bibliography** : Systematic Programming in Pascal , Niklaus Wirth Publisher: Campus , 4th edition ; Draft Algorithms , 2nd . edition, N. Ziviani , Thomson , 2004; C. - Programming Language ANSI , BW Kernigham , D. M. Ritchie , Harvard Business School Press , 1995. Languages accepted C, C + +, Fortran, Pascal / Delphi and Java. **c)** Numerical methods : interpolation and extrapolation , roots , FFT and applications. **Bibliography** : Numerical Recipes : The Art of Scientific Computing , William H. Press, Brian P. Flannery , Saul A. Tekolsky and William T. Vetterling , Cambridge University Press ; Computational Physics , Nicholas J. Giordano and Hisao Nakanishi , Pearson Education ; Computational Physics , Steven E. Koonin and Dawn C. Meredith , Addison Wesley .