



കുമ്പളത്തു ശങ്കുപിള്ള മെമ്മോറിയൽ ദേവസ്വം ബോർഡ് കോളേജ്

**KUMBALATHU SANKUPILLAI MEMORIAL  
DEVASWOM BOARD COLLEGE**

**Prospectus of  
M.Sc. Physics  
with  
Specialization in Nanoscience**

*University of Kerala*

**2020-2021**

# **PROSPECTUS FOR ADMISSION TO THE POST GRADUATE DEGREE PROGRAMMES IN THE COLLEGES AFFILIATED TO THE UNIVERSITY OF KERALA AND CENTERS OF THE UNIVERSITY FOR THE ACADEMIC YEAR 2020-2021**

## **1. INTRODUCTION**

**1.1** Prospectus for admission to the Post Graduate (PG) Degree programmes in Govt./Aided/Self Financing Colleges affiliated to the University of Kerala and Centres of the University (UIT's), for the academic year 2020-21, as approved by the University of Kerala, is published herewith. It contains general information and rules relating to the admission to PG Degree programmes in Govt./Aided/Self- financing affiliated Colleges under the University of Kerala & Centres of the University.

**1.2** The Prospectus issued by the University during the previous years for admission to PG programmes are not valid for the year 2020-21.

**1.3** Admissions to the seats to be filled by the University for the PG programmes (except those specifically mentioned) are regulated on the basis of grade/marks obtained in the qualifying examination. The details of seats, to which admissions are made through the rank list prepared accordingly, are contained in the relevant paragraphs.

**1.4** Statute 19 (3), of Chapter 24 of the KUFS 1977 which states that 'no student shall be admitted to any course of instruction in the colleges in anticipation of affiliation', shall be strictly adhered to, in all the colleges.

**1.5** Statute 31 of Chapter 24 of the KUFS 1977 which states that 'Admission of students to every College shall be subject to the conditions prescribed by the University and the strength of each class or subjects shall not exceed the maximum for the class or subject sanctioned by the Syndicate' shall be strictly adhered to in all the Colleges.

**1.6** Authority to prescribe qualification for admission to the various courses of studies. According to Sub-Section (v) and (vi) of Section 25 of the Kerala University Act, 1974, the Academic Council shall have the power to prescribe qualifications for admission of students to the various courses of study (and to the Examinations) and the conditions under which exemptions shall be granted, and to make provision for the admission of students to the various courses of studies on the basis of merit in order to maintain the standards of education.

**1.7** Agreement for Direct Payment - Relevant provisions for admission to the various courses in Aided Colleges. Article 29 of the Agreement for Direct Payment entered into between the Government and the Educational Agencies of Private Colleges stipulates that all future admission of students to the Private Affiliated Colleges shall be on the following basis, viz :-

**a)** Twenty percent of the total number of seats in each college under the Educational Agency shall be reserved for students belonging to the Scheduled Castes and Scheduled Tribes. Those seats which cannot

be filled on this basis shall be filled on the basis of merit from among backward minority communities, in case the college is run by a backward minority community and from among OBCs , in all other cases.

b) \*Ten/Twenty \*\*percent of the seats shall be reserved for the candidates belonging to the community to which the college belongs. These seats will be filled strictly on the basis of merit from among the students of the said community.

c) \*Fifty/Forty \*\*percent of the seats will be filled by open selection on the basis of merit.

d) The remaining seats will be filled by the Educational Agency by candidates of their choice.

Note: \* This will apply to Forward Community Colleges

\*\* This will apply to Backward Community Colleges.

**1.8** Admission to MBA, MCA, MAHRM, MPE, MSW, MFA, and MASLP courses will not come under the purview of Centralized Allotment Process.

## **2. GENERAL INFORMATION**

Admission to the PG programmes in the Arts and Science Colleges affiliated to the University of Kerala and Centers of the University were made on the basis of Online Centralized Allotment.

The Online allotment process will provide the candidates, opportunity of obtaining admission to any of the Colleges of the University / Centers and to any of the programmes of his/her choice on the basis of merit. Any candidate who desires to obtain admission under the University of Kerala for the PG Programme should compulsorily register online before the closure of registration, irrespective of the Category (General /SEBC/ EWS/ SC/ST/ Community /Management / Candidates from Union Territory of Lakshadweep/Jammu and Kashmir/ Malayalee students of Andaman / Differently Abled Persons / Widows and wards of defence Personnel killed or disabled in action or during peace time /Sports etc.) to which he/she belongs.

No Online Registration shall be permitted after the closing date. The allotment of the candidates to the various Programmes and Colleges will be on the basis of merit strictly following the rules and regulations regarding reservation. The marks at the Degree level would be the basic criteria for admission to the PG Programme.

## **3. PROGRAMMES, INSTITUTIONS AND SEATS**

### **3.1 Details of Programmes and Duration:**

The programme leads to Masters Degree in the relevant subject. The programme extends for a period of four semesters. The course of study shall be by regular attendance for the requisite number of lectures, practical training and other means.

### **3.2 Institutions and Subjects for the PG Degree Programmes:**

The list of colleges to which admissions are to be made and the programmes offered and the sanctioned strength are given as Annexure I, in the Prospectus.

### **3.3 Categorization of Seats:**

Seats available in Govt./Aided/Self financing Affiliated Colleges/UIT's are mainly classified as Merit Seats/ Community Quota seats/Management Quota seats and Reservation seats.

#### **a. Merit Seats:**

The seats in Government/Aided/Self financing Affiliated Colleges/UIT's that are filled purely on merit basis irrespective of the Category/Community to which the candidates belong, are classified as "Merit Seats."

#### **b. Community Quota Seats:**

The seats in Aided Colleges that are filled by the Colleges concerned, on the basis of merit from among the candidates who belong to the community of the Management who runs the College, are classified as 'Community Quota Seats'.

#### **c. Management Quota Seats:**

The seats in Aided and Self-financing affiliated Colleges that are to be filled by the Managements concerned are classified as "Management Quota Seats."

#### **d. Reservation Seats:**

The seats in Government/Aided/Self-financing Colleges/UIT's, which are earmarked for SC/ST/SEBC/ Economically Weaker Sections (EWS) in General Category/ Differently Abled Sports persons/ Transgender candidates etc. are classified as 'Reservation Seats'.

### **4. RESERVATION OF SEATS**

#### **Types of Reservations:**

Seats will be reserved for the following categories in Government/Aided/Self-financing Colleges/UITs for various PG courses. A candidate can claim only one benefit at a time as per his/her choice for a particular purpose.

#### **4.1 Reservation for Nominees:**

##### **a. Reservation for Candidates from Union Territory of Lakshadweep.**

An additional seat shall be created for each PG programme (wherever necessary) in all Government/Aided Colleges exclusively for the purpose of accommodating students sponsored by the Union Territory of Lakshadweep. This seat shall not be filled up by other candidates. The Head of the Institutions should forward the list of such candidates admitted, separately, to the University, immediately after admissions (Govt. Letter



No.5455/B3/2006/H Edn., dated 15.03.2006) (U.O.No.Ac.B/1/1134/2006 dated 26.04.2006). All such candidates should register online before obtaining admission.

**b. Reservation for Candidates from Jammu and Kashmir.**

Two seats shall be created over and above the sanctioned strength to accommodate candidates belonging to Jammu & Kashmir for admission to PG programmes (wherever necessary) in all the affiliated colleges. (U.O.No.Ac.B/1/2292/Admns/2012 dated 01.03.2013). Such students should also register online.

**c. Reservation for Malayalee students of Andaman.**

One Seat each be created for each PG programme (only wherever necessary) in all affiliated Arts & Science Colleges under University of Kerala exclusively for the purpose of accommodating Malayalee students of Andaman. The Head of the Institutions should forward the list of such candidates admitted, separately, to the University, immediately after admissions along with the documents to prove that the student belongs to the Malayalee community in Andaman. Such students should also register online. This seat shall not be filled up by other candidates.

**d. Reservation of seats for the widows/wards of Defence personnel killed/disabled in action or during peace time.**

Additional seats over and above the sanctioned strength may be created as and when required for the widows/wards of defence Personnel killed/disabled in action or during peace time in Central/ State Universities/ Autonomous Professional/Non-professional institutions under the purview of Ministry of Human Resources Development as per UGC policy. (Applicable to Army/Navy/Airforce only.

Not applicable to paramilitary forces/CAPF/GREF/Coast Guard etc.)

**4.2 Reservation for Differently Abled Persons:**

(i) 5% seats of the sanctioned strength shall be created over and above in Government/ Aided Colleges and UIT's, exclusively for candidates with benchmark disability (as per clause 32(l) of chapter VI, The Rights of Persons with Disabilities Act, 2016).

(ii) In all other affiliated Colleges, additional seats will be created over and above sanctioned strength for candidates with benchmark disability as and when required.

As per Clause 2 (r), Chapter I of the Rights of Persons with Disabilities Act, 2016, 'Person with benchmark disability' means a person with not less than 40% of a specified disability where specified disability has not been defined in measurable terms and includes a person with disability where specified disability has been defined in measurable terms, as certified by the certifying authority.

Candidates who have a minimum of 40% disability alone will be eligible to apply for this quota. Candidates seeking admission under Differently Abled category should submit the 'Certificate of disability', issued not earlier than 5 years prior to the submission of application, by the District Medical Board or bodies of higher

status, certifying the degree of percentage of disability. The Permanent Disability Card issued by the State Government is also considered.

Based on the details furnished in the online application, candidates will be provisionally included under the 'Differently Abled' category. Authorities of all Educational Institutions/Colleges affiliated to the University of Kerala are directed to make appropriate arrangements for medical examination of students with disabilities at the place of counseling/admission, in case, the authenticity of disability certificate being produced by the candidate is doubted. Otherwise, the disability certificate issued by the appropriate authority should suffice. (Circular No. Ac.BI/PH/2011, dated 26.02.2011).

The selection of candidates under this category will be based on the rank in the inter-se merit list and not on the basis of the degree of disability.

**Note:** Candidates with less than 50% physical disability (orthopaedically) may only apply for

M.Sc. Geology course. The candidates with blindness and colour blindness are not eligible to apply for the course. No reservation of seat is allowed for Blind candidates for Science subjects. University of Kerala 6 Prospectus - PG Admissions 2020

#### **4.3 Reservation for Transgender candidates.**

Two seats shall be created over and above the sanctioned strength in all courses in affiliated Arts & Science Colleges exclusively for admitting Transgender students. G.O.(Ms)No.153/2018 HEdn dated 03.07.2018). Such candidates should submit transgender identity card issued by the State Government at the time of admission.

#### **4.4 Special Reservation**

##### **(A) Sports Quota**

One seat shall be created over and above the sanctioned strength for sports persons in each subject for the Post Graduate Degree Programme. Admission to such seats shall be made by the Principal, from the Sports Quota ranklist approved by the University. If the required number of sportspersons is not available, the seats should be kept vacant and shall not be filled by other candidates. Norms for Admission to the Seats Reserved under Sports Quota for PG Courses. The following criteria will be considered for verification and ranking of sports achievement certificate as per the priority given below.

1 World championship -First

2 World championship -Second

3 World championship -Third

4 Olympics -First

5 Olympics -Second

- 6 Olympics -Third
- 7 World Championship- Participation
- 8 Olympics - Participation
- 9 Common Wealth championship - First
- 10 Common Wealth championship - Second
- 11 Common Wealth championship - Third
- 12 Asian Games - First
- 13 Asian Games - Second
- 14 Asian Games - Third
- 15 Common Wealth Championship - Participation
- 16 Asian Games - Participation
- 17 World University- First
- 18 World University - Second
- 19 World University- Third
- 20 SAF Games - First
- 21 SAF Games - Second
- 22 SAF Games - Third
- 23 World University- Participation
- 24 SAF Games - Participation
- 25 Senior National - First
- 26 Senior National - Second
- 27 Senior National - Third
- 28 Federation Cup - First
- 29 Federation Cup - Second
- 30 Federation Cup - Third

- 31 All India Inter- University - First
- 32 All India Inter- University - Second
- 33 All India Inter- University - Third
- 34 Khelo India University Games - First
- 35 Khelo India University Games - Second
- 36 Khelo India University Games - Third
- 37 Khelo India Youth Games - First
- 38 Khelo India Youth Games - Second
- 39 Khelo India Youth Games - Third
- 40 Senior National - Participation
- 41 Federation Cup Participation
- 42 Senior National Zone – First
- 43 Senior National Zone – Second
- 44 Senior National Zone – Third
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- 45 Junior/ Youth National - First
- 46 Junior/ Youth National - Second
- 47 Junior/ Youth National - Third
- 48 Khelo India University Games - Participation
- 49 Inter- University Zone - First
- 50 Inter- University Zone - Second
- 51 Inter- University Zone - Third
- 52 Inter- University Zone - Fourth
- 53 All India Inter University/Zonal University – Participation
- 54 Khelo India Youth Games - Participation



- 55 Senior National Zone – Participation
- 56 Junior/Youth Zone National -First
- 57 Junior/Youth Zone National -Second
- 58 Junior/Youth Zone National -Third
- 59 Junior/Youth National – Participation
- 60 Member of University team ( Non- Participation)
- 61 Junior/Youth Zone National – Participation
- 62 Senior State Championship - First
- 63 Senior State Championship - Second
- 64 Senior State Championship - Third
- 65 Senior State Championship – Participation
- 66 College Games (Kerala State Sports Council) – First
- 67 College Games (Kerala State Sports Council) – Second
- 68 College Games (Kerala State Sports Council) – Third
- 69 College Games (Kerala State Sports Council) – Participation
- 70 University Inter-collegiate – First
- 71 University Inter-collegiate – Second
- 72 University Inter-collegiate – Third
- 73 Kerala State Junior/ Youth Championships - First
- 74 Kerala State Junior/ Youth Championships - Second
- 75 Kerala State Junior/ Youth Championships - Third
- 76 Kerala State Junior/ Youth Championships – Participation
- 77 Senior District Championship - First
- 78 Senior District Championship - Second
- 79 Senior District Championship – Third

80 Junior/ Youth District Championship -First

81 Junior/ Youth District Championship -Second

82 Junior/ Youth District Championship -Third

General Guidelines for admission under Sports Quota in Affiliated Colleges and UIT's

- i)** The registration for Sports Quota admission shall be effected in online mode only.
- ii)** Candidates who seek admission under sports quota should apply online within the prescribed time.
- iii)** The certificates of achievement shall be scanned and uploaded in the website.
- iv)** The achievement certificate received before the closure of registration of PG Programmes will only be considered for ranking in sports quota admissions.
- v)** For securing admission to PG programmes under Sports Quota, including re-admission, the performance of the candidate during the preceding three years/ Degree Level shall only be considered.
- vi)** For filling up the seats reserved under Sports quota, hierarchy of preference shall be given as per the norms/guidelines formulated by the University in addition to satisfying his /her academic eligibility.
- vii)** When the candidates fulfil minimum academic eligibility, the academic merit shall not be preferred over sports merit in sports quota reservation seats except in the case of a tie in the sports merit.
- viii)** The candidates who wish to apply under sports quota should opt "Sports – Yes" during online registration. They need to select the level of achievement and upload corresponding certificate in the respective field in the website. There will be no limit in uploading the number of certificates.
- ix)** After completion of the registration process, the candidates shall submit a proforma in prescribed form to the colleges where they wish to apply for sports quota admission from among the colleges they have opted while registering online. The colleges shall then upload the application number of such candidates in the college login within prescribed time. Verification of sports achievement certificates will be done only for such candidates and the rank list will be prepared accordingly. It may be noted that the candidates will be included in the sports quota ranklist of those colleges only where they have submitted the proforma. (The format of proforma can be downloaded from the website. The candidates can submit the proforma to the colleges till the date of closure of University of Kerala 8 Prospectus - PG Admissions 2020 registration. The date of uploading of the application numbers of candidates who have submitted the proforma within prescribed time in the college login will be intimated later).
- x)** University will conduct centralized verification of uploaded certificates. Rank list will be published in the website after the verification.

**xi)** Admission will be effected by the Principal based on this rank list. Verification of original certificates will be done by the Head of the Department of Physical Education of the College concerned. Date of admission will be intimated through press release.

**xii)** The original certificate/s from the competent authority/ authorities (Secretary, Organiser etc. as per the Circular Letter No. Ad.D1.3.1276 /74 dated 23.01.1979) must be produced by the candidate to prove his/her claim.

**xiii)** If any discrepancy is noted during the verification of original certificates, the candidate shall not be considered for admission under sports quota. In case of a tie in sports merit, the following criteria will be considered to break the tie as per the priority given below.

**1.** A weightage of marks may be given to the candidates who have achievements in following games selected by the University for the purpose of tie breaking only (Major games). Football, Cricket, Basketball, Volleyball, Badminton, Kabaddi, Athletics and Aquatics

**2.** Preference shall be given to that candidate who represents the discipline (game /sport) of the choice of the college concerned (Annexure I.A)

**3.** Year of achievement (Preference shall be given to achievements in year closer to the year of application)

**4.** Academic merit.

No applications under Sports Quota will be entertained after the last date of registration. Only those candidates who upload the sports achievement certificates and who submit the proforma to the colleges within the prescribed time will be considered for admission under sports quota.

The List of sports disciplines considered for PG admissions is given below.

Sl. No. Events

- |   |                |
|---|----------------|
| 1 | Aquatics       |
| 2 | Archery        |
| 3 | Athletics      |
| 4 | Badminton      |
| 5 | Ball Badminton |
| 6 | Baseball       |
| 7 | Basketball     |
| 8 | Best Physique  |

- 9      Boxing
- 10     Canoeing and Kayaking
- 11     Chess
- 12     Cricket
- 13     Cross Country Races
- 14     Cycling Track and Road
- 15     Fencing
- 16     Football
- 17     Gymnastics
- 18     Handball
- 19     Hockey
- 20     Judo
- 21     Kabaddi
- 22     Kho-Kho
- 23     Netball
- 24     Power Lifting
- 25     Rollball
- 26     Rowing
- 27     Rugby
- 28     Softball
- 29     Squash
- 30     Table Tennis
- 31     Taekwondo
- 32     Tennis
- 33     Volleyball



- 34 Weight Lifting
- 35 Wrestling
- 36 Wushu
- 37 Yachting
- 38 Yoga

☐ Approved Association certificate, duly countersigned by the Kerala State Sports Council will only be considered for ranking, except two zones Games (Football, Cricket, Volleyball, Badminton, Kabaddi), Athletics & Aquatics conducted by University of Kerala.

☐ Approved Association certificates issued in the valid format only will be accepted.

**Important: The seats reserved under Differently Abled, Transgender and Sports Quota are created over and above the sanctioned strength. In the absence of the candidates who are eligible for these reservations, such seats will remain unfilled.**

#### **(B) Arts Quota**

Students who are declared as Kalaprathibha / Kalathilakam of the University of Kerala in any year during their Degree programme, and who are applicants for PG programme in a College affiliated to this University, during the succeeding academic year shall be admitted to the PG programme to the college which is their first option, if otherwise eligible, by creating seats over and above the sanctioned strength.

### **4.5 Mandatory Reservation**

#### **Aided Colleges**

Sl No.	Seat Reservation	Forward community Colleges	Backward community Colleges
I	General Merit Quota	50 %	40 %
II	Scheduled Caste	15 %	15 %
III	Scheduled Tribe	05 %	05 %
IV	Community Quota	10 %	20 %
V	Management Quota	The remaining seats (20%) after filling items (I) to (IV) will be filled by the Educational agency (ie. Management) by candidates of its own	

		choice adhering to all the eligibility conditions prescribed by the University.
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### **Mode of admission under Community Quota in Aided Colleges**

1. The seats under community quota in Aided Colleges will be filled by the Colleges concerned on the basis of merit and on the basis of community certificate issued by the Revenue Authorities/Parish Priest/any other Competent Authority.

2. The Community Quota registration will be effected in online mode. Candidates need not submit the application for community quota admission in colleges. The candidates may apply for Community Quota after completing the registration for centralized allotment. They can use the same application number of their original registration and shall submit separate options for Community Quota. The University of Kerala 10 Prospectus - PG Admissions 2020 shall use the "Community Quota" link provided in their profile for submitting the options. It may be noted that only those colleges, based on the community of the candidates, will be displayed for submitting options.

3. The candidates can give a maximum of 20 options. There is no preference in options.

**The candidates who do not submit separate options for Community Quota will not be considered for Community Quota admission.**

4. Candidates can add or delete options till the closure of online registration.

5. From the applications submitted, the University will prepare ranklist of the eligible candidates on merit basis and the same will be published in the website.

6. The candidates in the ranklist will be notified through press release, to appear at the opted colleges for certificate verification and admission thereafter, if eligible.

7. All admissions to Community Quota (including the vacant seats of SC/ST converted in case of Aided Backward colleges with Minority status) are to be effected from the Community Quota Ranklist of the colleges approved by the University.

**List of communities that are considered for Community Quota admission in various Aided Colleges are given in Annexure VI**

**No applications for Community Quota will be entertained after the last date of registration. Applicants claiming reservation under Community quota in Aided Colleges, who belong to the community of the Management which runs the college, will have to produce community certificate from the Revenue authority/Parish Priest/any other competent authority concerned, at the time of admission.**

### **Mode of admission under Management Quota in Aided Colleges**

1. The candidates seeking admission to the management quota seats in Aided register online.
2. There is no centralized allotment for Management Quota. Candidates should contact the colleges he/she intends to take admission and submit the printout of the application form to the colleges concerned.
3. After closure of registration for the centralized allotment process, registration exclusively for management quota seats will be open. The candidates seeking admission under Management Quota alone can apply till the closure of admission. It may be noted that this Management Quota registration can be used for admission to Management Quota seats only.
4. If a candidate has already registered for centralized allotment process, it is sufficient for admission under management quota also. There is no need of separate registration under management quota.

### **4.6 General Rules for conversion of vacant seats**

#### **(b)Aided Colleges**

Aided Colleges If sufficient candidates are not available for filling the seats reserved for SC/ST candidates in Aided Colleges, the same will be notified in the media three times (on three different dates) and a separate allotment for SC/ST candidates will be made by the University. However, even after this, if SC/ST seats are still vacant, same will be filled as per the following norms.

1. The vacant SC/ST seats if any, in Aided Forward/Backward Colleges will be filled by admitting candidates belonging to Socially and Educationally Backward Communities (SEBC), strictly in accordance with the rules and guidelines for admission. The seats that still remain un-filled will go to the General Merit Quota.
2. The vacant SC/ST seats if any, in Backward Aided colleges with Minority Status will be filled by admitting candidates from the Community Quota Ranklist of the colleges, strictly in accordance with the rules and guidelines for admission.

### **5. CLAIMS FOR MANDATORY RESERVATION AND CERTIFICATES TO BE PRODUCED**

(i) Claims for Mandatory Reservation must be made by a candidate at the time of submission of online application. Candidates should mention their claim in the relevant columns in the Personal and Academic Data Sheet. They should also satisfy the eligibility conditions as per the Prospectus (Clause 6) at the time of online registration.

(ii) Candidates should produce all original documents to prove their claims made in the online application form at the time of admission before the Principal. Claims that are not mentioned at the time of submission of online application will not be entertained even if supporting evidences are produced later on.

**The claims for mandatory reservation once made cannot be altered by the candidate under any circumstances.**

#### **5.1 Claim for reservation under 'Socially and Educationally Backward Classes' (SEBC).**

Reservation of seats to the Socially and Educationally Backward Classes will be in accordance with the provisions contained in G.O. (P) 208/66/Edn. Dated 2.5.1966, as amended from time to time. Candidates belonging to Ezhava,

Muslim, Other Backward Hindu, Latin Catholic/SIUC and Other Backward Christian communities, claiming reservation under SEBC quota should invariably produce 'Non Creamy Layer Certificate' obtained from the Village Officer concerned. Candidate belonging to Non Creamy Layer category only are eligible for claiming reservation to SEBC category. Annual Income is not a criteria for reservation for SEBC candidates.

List of communities under SEBC category are given in Annexure V.

### **5.2 Claim for reservation under Scheduled Castes (SC) / Scheduled Tribes (ST) quota.**

Candidates belonging to SC/ST communities allotted against merit seats or against the seats reserved for them are exempted from payment of fee at the time of admission. Candidates claiming reservation under Scheduled Castes/ Scheduled Tribes quota should obtain the Caste/Community Certificate from the Village Officer/Tahsildar. (See Annexure II and Annexure III for list of SC and ST)

**Warning: Those who produce false SC/ST Certificate for claiming reservation under SC/ST quota shall be liable for penalties as per rules.**

**The seats unavailed by the SC candidates will go to ST candidates and vice versa.**

### **5.3 Claim of OEC candidates against the un-availed seats of SC/ST candidates.**

Other Eligible Community (OEC) candidates are eligible for the un-availed seats, if any, under SC/ST quota. The communities given in Annexure IV only are eligible for such un-availed seats, if any, under SC/ST quota (G.O.(Ms)No.14/2017/BCDD dated 02.08.2017). OEC candidates who possess 'Non Creamy Layer Certificate' obtained from the Village Officer concerned alone are eligible for such seats.

**Note : Converted Christians do not come under the SC/ST category. They belong to OEC category. (Ref. Annexure IV) University of Kerala 12 Prospectus - PG Admissions 2020**

### **5.4 Claim for fee concession to OEC candidates.**

Candidates belonging to Other Eligible Communities are exempted from payment of fee at the time of admission under Government/Community quota irrespective of annual family income as per G.O (MS) No. 36/07/SCSTDD, dated: 03.07.2007.

(Communities listed in Annexure IV) OEC candidates will be granted the fee concession based on the Non-Creamy Layer Certificate. But those OEC candidates who do not come under Non-Creamy Layer Category should produce the Community Certificate obtained from the village officer at the time of admission for availing the fee concession.

### **5.5 Claim for fee concession to the candidates who get OEC educational assistance.**

As per the G.O.(Ms) 10/2014/BCDD dated 23.05.2014, 30 communities from state OBC list are selected for OEC educational assistance subjected to a maximum of Rs. 6 Lakh annual income. (Communities listed in Annexure V.A) They should provide Community and Income Certificates from the Village Officer at the time of admission.

### **5.6 Claim for reservation under Economically Weaker Sections (EWS) in General Category in Govt./Self Financing Colleges and UIT's**



Candidates belonging to FORWARD COMMUNITIES who are economically backward are eligible for EWS reservation. Such candidates must produce either of the certificates from the village officer namely “The applicant belonging to Anthyodaya Anna Yojana (AAY) and Priority House Hold (PHH) category” or “The income and assets certificate for Economically Weaker Sections (EWSs) in General Category”.

(Format of certificates is given in Annexure XI and XII).

**Ration Card or BPL certificate is NOT a valid document to avail EWS reservation. Candidates who enjoy Communal Reservation such as SEBC, SC/ST are NOT eligible for EWS reservation.**

**5.7 Notwithstanding anything contained in the Statutes, the selection of students in Government colleges shall be governed by the rules prescribed by the Government from time to time with the concurrence of the University in respect of such admissions.**

## **6. ELIGIBILITY FOR ADMISSION**

### **6.1 Nativity:**

**6.1.1 Candidate should be an Indian citizen. Candidates seeking admission to PG Programmes will be categorized as Keralite and Non-Keralite.**

(i) Keralite: A candidate of Kerala origin will be categorized as a Keralite. Children of All India Service Officers allotted to Kerala Cadre are deemed to be Keralites as per G.O. (Rt) No.822/08/H.Edn. dated 9-5-2008. But they will not be eligible for communal/special reservation.

(ii) Non-Keralite: A candidate who does not come under Keralite category will be categorized as Non-Keralite. Non-Keralite candidates will be eligible for admission only after all the applicants of Keralite origin are ranked and allotted. Such candidates are not eligible for Communal reservations or any kind of fee concession.

**6.1.2 In order to prove that a candidate is an Indian citizen of Kerala origin for the limited purpose of eligibility for admission, he/she has to produce any one of the following certificates at the time of admission.**

(a) In the case of candidates who have undergone College studies in Kerala, a Course Certificate from the Head of the educational institution last attended in Kerala, certifying that the candidate has undergone his/her studies in Kerala for not less than 3 (three) continuous years within a period of 12 (twelve) years, immediately prior to the completion of the Bachelor’ Degree or equivalent examination.

OR

(b) A certificate from the Village Officer/ Tahsildar to show that he/she or his/her mother/father was born in Kerala.

OR

(c) Certificate from the Village Officer/Tahsildar to the effect that the candidate has been a resident of Kerala State for a period of five years within a continuous period of twelve years

OR

(d) The true copy of relevant page of Secondary School Leaving Certificate showing the candidate's Place of Birth is in Kerala.

OR

(e) The true copy of the relevant page of the Secondary School Leaving Certificate showing Place of Birth in Kerala of either of the parents of the candidate with corroborative certificate to establish the relationship between the parent and the candidate. University of Kerala 13 Prospectus - PG Admissions 2020

OR

(f) The true copy of the relevant page of the Passport of the candidate, issued by the Government of India, showing Place of Birth in Kerala or of either of the parents of the candidate showing Place of Birth in Kerala with corroborative certificate to establish the relationship between the parent and the candidate.

## **6.2 Academic Eligibility**

a).Candidates should have passed the corresponding Degree examination under the 10+2+3 pattern with Core Course and Complementary Course/with one main subject and two subsidiary subjects from any of the Universities in Kerala or of any other University recognized by the University of Kerala as equivalent thereto for admission, subject to the stipulation regarding grade/marks.

b).Double or Triple main candidates or candidates who have passed the Degree Examination in Vocational or Specialized Courses are also eligible for admission. However, they have to submit a copy of the Equivalency and Eligibility certificate from the University of Kerala, stating that, their qualifying examination is recognized for seeking admission to the relevant PG Degree programme as applicable, at the time of admission.

c).The minimum requirement of grade/marks for admission to PG Degree programmes is given in the relevant sections.

**No rounding off of the percentage of marks to the nearest whole number is permitted.**

## **6.3 Choice of optional subjects**

The optional subject for the PG Degree programme should be the same as the one, which the student has selected as Core Course for Graduation, or the main subject for Graduation conventionally recognized to be coming under the optional chosen. In case, the Core Course is different from the subject opted for admission, the eligibility will be decided as per the existing rules of the University.

**6.4 Eligibility Criteria** Candidates seeking admission to PG Degree programme have to satisfy the academic eligibility as described in the following sub clauses:

**See annexure for University order**

	<b>M.Sc.Courses</b>		
	<b>Graduates who have passed qualifying examination in CBCS Pattern -2013 admissions onwards</b>	<b>Graduates who have passed qualifying examination in CBCS Pattern- Prior to 2013 admissions</b>	<b>Graduates who have passed qualifying examination in Annual scheme/ Other pattern</b>
	<b>M.Sc Physics with Specialization in Nanoscience</b>  B.Sc. with Physics as Core Course and Mathematics as one of the Complementary Course securing not less than 5.5 CCPA(S) * out of 10 / B.Sc. Optical Instrumentation (Vocational), Instrumentation (Vocational) / Electrical Equipment Maintenance (Vocational), Computer Applications (Career Related/ Vocational) / B.Sc. Physics & Optical Instrumentation (Restructured)/B.Sc.	<b>M.Sc Physics with Specialization in Nanoscience</b>  B.Sc. with Physics as Core Course and Mathematics as one of the Complementary Course securing not less than 2.2 CGPA(S) * out of 4 / B.Sc. Optical Instrumentation (Vocational), Instrumentation (Vocational) / Electrical Equipment Maintenance (Vocational), Computer Applications (Career Related/ Vocational) / B.Sc. Physics & Optical Instrumentation (Restructured)/B.Sc. Physics & Computer	<b>M.Sc Physics with Specialization in Nanoscience</b>  B.Sc. with Physics as optional Main subject and Mathematics as one of the subsidiary subjects under Part III securing not less than 55% marks for that part/ B.Sc. Optical Instrumentation (Vocational), Instrumentation (Vocational)/Electrical Equipment Maintenance (Vocational), Computer Applications (Vocational)/ B.Sc. Physics & Optical Instrumentation (Restructured)/ B.Sc. Physics & Computer Applications (Restructured)

	Physics & Computer Applications (Career Related/Restructured)	Applications (Career Related/Restructured)	
	Existing ranking criteria for PG programme be followed.	Existing ranking criteria for PG programme be followed.	Existing ranking criteria for PG programme be followed.

\*CCPA(S) is CCPA for specialized subjects (it is computed without considering the Language Courses, Foundation Course for Language and Open Course).

#### 6.5 Relaxation in Grade Points/Marks in the Qualifying examination:

	Under CBCS PATTERN	ANNUAL SCHEME
6.5.1	<b>Scheduled Caste/Scheduled Tribe Category:</b>  A pass in the Qualifying Examination with minimum CGPA(S) of 1.5(CBCS Prior to 2013 admissions)/CCPA(S) of 4 (CBCS 2013 admissions)	<b>Scheduled Caste/Scheduled Tribe Category:</b> The minimum mark in the qualifying examination for PG Degree course of study is 35%.
6.5.2	<b>SEBC Category:</b>  A relaxation of 2% in the Qualifying Examination from the prescribed minimum is allowed	
6.5.3	<b>Persons with Disability Category (Differently Abled):</b>  A relaxation of 5% in the Qualifying Examination from the prescribed minimum is allowed.	
<b>All grades will be converted into Percentage of marks for preparation of rank list</b>		

## 7 PREPARATION OF RANKLIST



The rank list for PG Degree Programmes will be prepared on the basis of marks/CGPA/CCPA obtained in the qualifying examination in Part III Subjects/Core and Complimentary Courses, (including weightage/deduction wherever applicable), unless otherwise mentioned.

The rank list will be prepared based on the total marks/ Percentage of CGPA(CBCS Prior to 2013 admissions)/ CCPA(CBCS 2013 admissions onwards) (converted by the formula provided by respective University) obtained by the candidate out of 1000.

	M.Sc. Programme	M.Sc. Programme	M.Sc. Programme
	<b>Graduates who have passed qualifying examination in CBCS Pattern -2013 admissions onwards</b>	<b>Graduates who have passed qualifying examination in CBCS Pattern- Prior to 2013 admissions</b>	<b>Graduates who have passed qualifying examination in Annual scheme/ Other pattern</b>
	The candidates will be ranked on the basis of the CCPA(S) plus the CCPA of the core ie $A = \{((CCPA(S) * x \text{ Total Credits}) + (CCPA \text{ of Concerned Core Course} * \text{Credit of Concerned Core Course})) / (\text{Total Credits} + \text{Credit of concerned core course})\}$ $B = A * 10$ (*symbol for multiplication) B is then normalized to 1000.	The candidates will be ranked on the basis of the CCPA(S) plus the CCPA of the core ie $A = \{((CCPA(S) * x \text{ Total Credits}) + (CCPA \text{ of Concerned Core Course} * \text{Credit of Concerned Core Course})) / (\text{Total Credits} + \text{Credit of concerned core course})\}$ $B = A * 10$ (*symbol for multiplication) B is then normalized to 1000.	The candidates will be ranked on the basis of the CCPA(S) plus the CCPA of the core ie $A = \{((CCPA(S) * x \text{ Total Credits}) + (CCPA \text{ of Concerned Core Course} * \text{Credit of Concerned Core Course})) / (\text{Total Credits} + \text{Credit of concerned core course})\}$ $B = A * 10$ (*symbol for multiplication) B is then normalized to 1000.

Weightage/ Deduction of marks: a. Weightage of Marks : Five (5) marks each for certificate holders of National Service Scheme [NSS]/ National Cadet Corps [NCC] for participation in NSS/NCC at the Degree level. Weightage marks may be added to the marks scored by the candidate either to make him eligible for admission to a course of study or for ranking purposes to those who are otherwise eligible for admission . In the case of candidates who get this eligibility by this bonus marks, their ranking mark will be the sum of scored marks and the bonus marks.

#### **Weightage/ Deduction of marks:**

##### **a. Weightage of Marks :**

Five (5) marks each for certificate holders of National Service Scheme [NSS]/ National Cadet Corps [NCC] for participation in NSS/NCC at the Degree level. Weightage marks may be added to the marks scored by the candidate either to make him eligible for admission to a course of study or for ranking purposes to those who are otherwise eligible for admission . In the case of candidates who get this eligibility by this bonus marks, their ranking mark will be the sum of scored marks and the bonus marks

**Note:**

(i) In respect of candidates who want to avail bonus marks for NCC, the marks will be awarded on the basis of NCC Weightage Certificates signed by the Director and issued by the Directorate of NCC to the candidates who have secured at least 75% of attendance after having participated in its activities during the course of study immediately preceding the course for which admission is sought.

(ii) In respect of candidates who want to avail bonus marks for NSS, the marks will be awarded on the basis of NSS Certificates signed by the Vice-Chancellor and issued by the University to volunteers who have completed 240 hours of work within a period of two years in the course of study immediately preceding the course for which admission is sought.

(iii) The benefit of bonus marks for purpose of admission can be availed by the candidates only under any one category (either NCC or NSS).

**b. Deduction / Loosing of marks for subsequent appearances:**

Candidates will lose 10 marks for ranking purposes from the total ranking marks for each additional appearance he/she has taken for completing the qualifying examination.

**Note:** Number of chances means the number of chances for passing any part of the qualifying examination excluding cancellation.

**7.5 Resolving of Tie**

In the case of more than one candidate obtaining equal index marks (Including weightage/ deduction as per Clause 7.4, if applicable), the candidate who has scored more marks in Part III Main will be placed higher in ranking. If the tie persists, the candidate who has scored more marks in Part I / Part II English will be placed higher in ranking. In the case of ranking for M. A. English, the conditions in clause 7.1.1 will be applicable. If the tie still persists, the age of the candidates will be taken into account, the older being placed higher in the ranking. Even after this exercise, if the tie persists the alphabetical order of the first name of the candidates will be taken into account.

**7.6 Joining for a PG course after cancellation of a course.** Candidates undergoing various courses in the University or who have registered/appeared for any of the PG examinations of the University in regular mode are permitted to cancel registration/examination for the purpose of joining for the same course in the University in regular mode, as a one-time provision, only under any of the exigent circumstances as detailed below.

- i. Issues in the college where he/she has pursued the course (like ragging, issues with college authorities/ other students etc)
- ii. Distance from home town.
- iii. Non availability of college hostel.
- iv. Death or serious illness of parents/supporting guardian.
- v. Illness of the candidate causing disability/serious illness of the candidate.
- vi. Difficulty to commute due to accident, surgery etc.
- vii. Difficulty to continue studies due to financial crises in the family. Candidates who have cancelled a course from this University or any other Universities and joining for any PG programme under the University of Kerala shall submit cancellation memo of previous course at the time of admission to the college.

**7.7 Pursuing additional PG degree.** A PG degree holder can take an additional PG degree only through distance mode. Candidates who are desirous of taking additional PG in subjects which are not offered through the distance mode are permitted to apply for admission to such courses in the University departments or affiliated colleges where these subjects are offered, if they are otherwise eligible.

## **8 HOW TO APPLY**

- 8.1** (a) Any candidate who wishes to join PG Programme in colleges affiliated to University of Kerala should compulsorily register online at <http://admissions.keralauniversity.ac.in>.
- (b) The site is optimized with the latest versions of Mozilla firebox, Google chrome etc.
- (c) The candidates are advised to enable “JavaScript” before proceeding with the Registration.
- (d) Read the instructions carefully before proceeding with the registration.
- (e) Do not press “back” button during the process of registration.

### **8.2 a. Generating Application Number and Password**

The first step of PG online registration process is generating application number and password. For this, the candidates have to click on "Click here for Registration" button available in the PG page of the website [www.admissions.keralauniversity.ac.in](http://www.admissions.keralauniversity.ac.in). After that, the candidate has to provide the minimum details like Exam Board / University, Register Number, Year of Passing, Name, Date of Birth, Gender, Category and Email id. After entering the required details, the candidate will be provided with a unique **application number** and **password**. Date of birth is the default password in the format **dd/mm/yyyy**

<b>Note down the Application Number and Password for future use.</b>
--

This application number and password must be used for all the PG online admission related activities. Till the prescribed date and time, candidates can login to the site with these credentials.

## **b. Login**

The candidate should login with the Application number and Password which they have generated through the previous step.

## **c. Instructions for Online Registration**

Candidates are advised to read the instructions carefully before registration. After reading the instructions click the "**Proceed**" button. **Do not press "BACK" button during registration.**

### **8.3 STEPS FOR THE ONLINE REGISTRATION PROCESS ( 1 To 7 ).**

#### **Step 1 : Payment of Registration Fee**

The Registration Fee will be as follows:

**1. For General / SEBC candidates: Rs. 600/-**

**2. For SC/ST candidates: Rs. 300/-**

Candidates should pay the registration fee by using the online payment facility after clicking on "Pay Online" button

**Candidates shall not remit the fee in any other form like Demand Draft, Cheque, Chalan etc.**

The payment can be made using Net Banking, Debit Card or Credit Card. After the Successfully online payment, it automatically redirect to the next step for the online registration process. After completing the payment, the candidate should continue the registration process.

**Note : The online payment receipt should be kept safely as the same is to be submitted to the college at the time of admission.**

**The Registration fee once remitted will not be refunded under any circumstances.**

#### **Step 2 : Candidate Profile Registration**

Candidate should enter the personal details here. Fields marked with \* are mandatory.

1. Name (As in the certificate of the qualifying examination).
2. Date of Birth (dd/mm/yyyy format).
3. Gender (Choose Male/Female/Transgender).
4. Keralite: Whether Keralite or not? (See prospectus clause 6.1)
5. Nationality: Whether Indian or not?
6. Land Phone: Enter Land Phone Number with STD Code.
7. Contact Mobile No: Enter Mobile Number.
8. Email: Enter Email id.
9. Address: The candidate has to provide permanent address for communication.
10. Religion : Select the Religion of the candidate.



11. Caste : Select the caste of the candidate.

11.a. Whether Creamy Layer :

Select the Creamy layer/Non Creamy layer. If the candidate choose Non Creamy layer, he/she has to submit certificates to support the claim at the time of admission

12. Category:

Based on the caste, the system will automatically populate the reservation category.

13. Allotment Category:

Based on the caste and creamy layer status, the system will automatically populate the allotment category. It is to this category that the candidate will be considered for allotment.

14. OEC:

It mentions to claim for OEC candidates. Based on the caste, the system will automatically populate this. The candidate has to submit certificates to support the claim at the time of admission. (Clause 5.3 and 5.4) (List of OEC is given in Annexure IV)

15. Differently Abled :

It mentions to claim reservation of seats for candidates with benchmark disabilities. If the candidate chooses YES, he/she has to submit certificates to support the claim (Clause 4.2).

16. EWS:

It mentions to claim reservation seats for candidates belonging to forward community who are economically backward (Economically Weaker Sections – EWS in General Category). If the candidate chooses YES, he/she has to submit certificates to support the claim. (Clause 5.6)

17. Special Weightage:

Candidate can claim if he/she has any weightage for NCC/ NSS. Documents should be available with candidate to support the claim. (See prospectus clause 7.4.a)

18. Are you Kala Thilakam / Kala Prathibha in University of Kerala for any year during your Degree course?

19. Reservation for Nominees : (See prospectus clause 4.1)

20. Have you represented any sports competitions? :

The candidate can select 'YES' if he/she wishes to apply under sports quota. He/she has to opt the level of achievement and also mention the sports item.

After completing the profile registration, the candidate can continue registration by clicking button "Save and Continue". It directs to the page, Academic Profile Registration.

### **Step 3: Academic Profile Registration.**

Enter details of marks obtained by the candidate in the qualifying examination.

#### **♣ Select the University:**

Select the name of university from the list (University of Kerala, Cochin University Science and Technology, Kannur University, University of Calicut, Mahatma Gandhi University). If the name of the University is not listed, then select 'Other'; and enter the name of university.

#### **♣ Select the Degree Programme:**

Select the Degree Programme from the list (BA/B.Sc/B.Com etc).

#### **♣ Specialization:**

Specialization such as English, Physics, Commerce etc.

#### **♣ Number of Appearances:**

The number of chances availed by the candidate to complete the qualifying examination.

#### **♣ Year of Passing:**

Select the year of passing of qualifying examination.

#### **♣ Examination Register Number:**

The Register number of qualifying examination (Degree Level).

♣ **Mark Details:**

Choose appropriate Mark System. If the candidate has studied under Grade system in any other University other than University of Kerala , it is his /her responsibility to convert his /her grades into marks by following the directions from his/her University and produce the valid documents at the time of admission. He/She should specify the additional qualifications, he/she is having from the list given.

**Step 4: Upload photo and Signature:**

Photo [ 150px X 200px (WIDTH X HEIGHT), 40kb, .jpg format only] must be clear and with light background.

Signature [with 150px X 60px (WIDTH X HEIGHT), 40kb, .jpg format only] must be clear.

For uploading photo and signature, select the image file in the computer using "Browse" button.

After uploading the photo and signature, click "Continue" button for further registration.

**Step 5: Add and Change Options.**

- Selection of choices is to be done with utmost care. On each selection of programme/college options, the same be added to the list of options by invoking "Add Option" button. A student can add up to a maximum of 20 options.
- The preference numbers along with the selected options shows the priority of options. So candidate must be very careful in prioritizing their options.

**The steps involved in changing the preference of options are summarized below.**

a. Select the option to be changed.

b. Suppose the candidate wants to change preference to a higher one (eg:-option with preference no.3 need to be changed to the one with preference no 2), click the row with the option to be moved, click Up arrow ( ) once, so that it will be changed accordingly. By clicking the down arrow ( ), the candidate can bring the preference to a lower one. If option 5 is to be brought to 2, the up arrow has to be clicked thrice. Existing option can be deleted by clicking the ( ) button link.

c. **DO NOT FORGET to click the button 'Save & Refresh Options' to finalize changed priority options.**

**Step 6: Verify the Application**

After adding all the options click "Preview and Verify Completed Application" button for further registration. A thorough verification be performed before taking printout. Provision for editing is permitted in some specific fields in each section. University of Kerala 31 Prospectus - PG Admissions 2020

**Step 7: Print out of completed application form**

Click the 'Print Completed Application' button to take the print out of the completed application form. The Registration process is completed only after taking the print out of the completed application form. Candidates are instructed to submit their application online within the time schedule specified, through the admission portal.

**8.3.1 Mode of Registration for Sports Quota**

The candidates who opt YES to the question "Have you represented any sports competitions?" in the first step of online registration process will be provided with an intermediate step after Step 5 (After Adding Options), for uploading sports achievement certificates. They have to select the level of achievement and upload scanned copy of corresponding certificate in the respective field. There will be no limit in uploading the number of certificates. Once the certificates are uploaded, registration process can be continued. It may be noted that the candidates who complete the registration for sports quota by uploading the sports achievement certificates and those who wish to apply under sports quota shall submit a proforma also to the colleges before the closure of registration (See General Guidelines for admission under Sports Quota in Affiliated Colleges and UIT's in clause 4.4).

**8.4 Updating the information and options already given online:**

A candidate can edit some of the information given at the time of registration, by entering the Home Page using his/her application number, and password (Date of Birth given as default password) as per the following procedure:

1. Go to the PG page in the website <http://admissions.keralauniversity.ac.in> and enter the application number and Date of Birth which is given as password in the 'Applicant Login' section. (Date of Birth is in the format **dd/mm/yyyy**). It is advised to change the password immediately using the link **"PASSWORD"** to prevent any type of intrusion by an unauthorized person. The candidate should note down the password and application number.
2. An authorized applicant will be directed to his/her home page with a group of navigation links (My Home, Index Mark, Edit Profile, Completed Profile, Password and Logout). In the link **'My Home'** the applicant can view the status of the application. Click the **'Preview & Print Completed Application'** button to view / print the application.
3. For updating the personal profile, the candidate has to go to the **'Personal Profile'** link where he/she can edit some of the information given at the time of online registration.
4. The link **'My Options'** is provided for the candidate to add/delete/change the preference of the Options.
5. If the candidate wishes to change the existing password, he/she can use the link **'Password'**. 6. After effecting all the changes, the latest printout be taken from 'Completed Profile' page.

**The candidates are advised to use the 'Logout' link at the time of exit from his/her Home Page**

**Do not send hard copy of online registration to the university. The hard copy of the online application with originals of all certificates should be kept by the candidate and has to be submitted at the time of admission in the respective college. The candidate who fails to produce the printout of the application form and original certificates at the time of admission shall not be considered for admission.**

## **9 ONLINE CENTRALIZED ALLOTMENT PROCESS**

### **9.1 Trial Allotment:**

A trial allotment will be published before the closure of registration in the profile of the candidate, to give an idea about the chances of getting admission to a Programme at a particular college, based on the options registered by the candidate. The trial allotment does not guarantee admission to the candidate.

### **9.2 First Allotment:**

After the trial allotment and the period earmarked for revising options, the first allotment will be published in the website on the date to be notified. Candidates can check the details of allotment in the "Allotment" link provided in their profile. The candidates who get allotment have to remit the University fee as per the procedure mentioned in clause 9.3 and ensure their seat, and those who fail to remit the fee in time will not be considered for further allotments. The candidates will have to follow the notification of the University with regard to the date of admission in the college concerned.



### 9.3 Fee to be paid to the University on Allotment

On securing allotment, the candidates have to remit the University admission fee mentioned in clause 10 through online mode (e-payment) only in the 'Allotment' page of valid applicant's homepage in the website (<http://admissions.keralauniversity.ac.in>). A printout of the payment receipt should be taken and the same should be kept safely and be submitted to the Principal at the time of admission. The candidate without the payment receipt will not be allowed to join the college. The candidates should keep a copy of the payment receipt. It will be required for further allotments, if any.

**Candidates SHALL NOT remit the fee in any other form like Demand Draft, Cheque, Chalan etc.**

Those candidates who do not remit the University admission fee on or before the date specified will lose their current allotment and will not be considered for further allotments.

### 9.4 Cancellation/Activation of options after the first allotment:

Candidates who remit the fee after first allotment within the prescribed time will have the facility to cancel/activate their higher options before the second allotment during a specified period which will be notified.

**9.4.1** After the first allotment, the options below the '**allotted one**' of the candidate will automatically be removed from the option list of the candidate. For example, if a candidate had registered 20 options in all, and if he/she is allotted his/her 10th option, all options from 11 to 20 will be automatically removed from the option list. Options from 1 to 9 will remain valid and will be considered for future allotments. He/she may cancel/activate any options among the remaining options as per his/her choice. But the candidate will not be permitted to register any fresh options to the existing ones.

**9.4.2** Existing options registered by the candidate, available in the Home Page, can be cancelled one by one by clicking the "CANCEL" button shown against each option or all higher options can be cancelled by clicking "CANCEL ALL HIGHER OPTIONS" button, **if the candidate desires so. Option once cancelled can be activated again using "ACTIVATE" button**, within a specified time period.

**9.4.3** If a candidate is satisfied with an allotment and does not want to be considered again for further allotment(s), he/she must cancel all the remaining higher options. A candidate retaining all or any



of his/her higher options after an allotment, is bound to accept the new allotment, if any, failing which, he/she will lose the existing allotment as well as the new allotment; moreover he/she will not be considered for any further allotments.

**9.4.4** The facility for cancellation/activation of options will be available during the notified period only.

**9.5 Second Allotment and Remittance of Fee.**

The second allotment list will be published on the date to be notified. A candidate who gets an allotment at any stage will have to remit the prescribed fee for the course allotted, through the method specified in Clause 9.3

**9.6 Downloading Allotment memo.**

After the second allotment, candidates can Login to their homepage using their application number and password for downloading the memo (Allotment memo can be downloaded only by those candidates who have remitted the University admission fee as per clause 9.3). Using the link 'Allotment' the applicant can view his/her allotment details and can download the allotment memo which has to be produced before the Principal at the time of admission. The allotment memo will show the personal details, the college, the Programme to which the candidate is allotted and the date of reporting to the college for taking admission.

**It is advised to keep a copy of allotment memo with the candidate for future purpose if any.**

**Allotment memo issued to a candidate for a particular allotment will not be issued again at a later stage under any circumstances.**

**9.7 Post Allotment Activities**

**9.7.1 Reporting at the College:**

Allotted candidates have to report before the Principal/Head of the College/Institution concerned on the dates notified for admission, with the documents mentioned in clause 10.

**Candidates can take temporary or permanent admission (See clause 9.9)**

### **9.7.2 Fee to be remitted in colleges at the time of admission:**

Apart from the fee already remitted to the University as per Clause 10, the fee applicable to the programme / institution has to be remitted to the college at the time of admission.

- ☐ The fee due to the colleges shall not be levied in advance from candidates belonging to SC/ST, OEC and also from candidates who get OEC educational assistance.
- ☐ All candidates (including SC/ST/OEC) will have to pay the “Caution Deposit” during admission as per rules.
- ☐ PTA fund shall not be compulsorily levied from SC/ST candidates.

### **9.7.3 Verification of Documents:**

The Principal/Head of the Institution shall be personally responsible for verification and satisfaction of the correctness of the records produced by the candidate at the time of admission in the College/Institution. The candidates should fulfill the eligibility criteria at the time of online registration and all relevant documents mentioned under clause 11 shall be submitted at the respective colleges during the time of admission.

### **9.7.4 Failure to report for Admission:**

Candidates who do not take admission on the prescribed date and time in the allotted college will lose their admission and they will not be considered for further allotments.

### **9.7.5 Cancellation of Higher Options after joining a college:**

Candidates who joined the college on the date specified, can either cancel their remaining options fully or partially or change the priority of their remaining options before the date specified as per the procedure specified in Clause 9.4. If not interested in any further allotments, all the higher options may be cancelled before the date specified, failing which, the options that remain valid will be considered for further allotments, if any.

### **9.8 Supplementary / Further allotments.**

Candidates who get allotment in supplementary/further allotments shall follow the instructions

given in clause 9.3, 9.4, 9.6 and 9.7

**The candidates need to remit the University admission fee only once during this process of allotment which would confirm their seat in any of the colleges as per their preference and eligibility.**

### **9.9 Temporary Admission.**

Candidates can opt for temporary admission in colleges upto 3rd allotment. They will be given an extended time for remitting the fee applicable to the programme / institution till this period. Such candidates,

- ☐ Have to submit the original certificates and the receipt of University admission fee.
- ☐ They can choose whether to take temporary or permanent admission and the same need to be assured by the Principal. The admission, whether permanent / temporary will be given in the admit memo issued to the candidates.
- ☐ This provision is not applicable from 4th allotment and it is compulsory to take permanent admission in the college by remitting the requisite fee.
- ☐ If they are satisfied with any of the allotments, they can take permanent admission by remitting the requisite fee.

### **10. FEE TO BE REMITTED TO THE UNIVERSITY FOR ADMISSION**

Any candidate (except SC/ST/OEC candidates) who get allotment / admission shall compulsorily remit the below mentioned University admission fee for taking admission in the college.

Sl. No	Particulars of the Fee to be remitted	Amount
1.	Medical Inspection fee (one time payment for two years)	Rs.20/-
2.	Sports Affiliation Fee (one time payment for two years)	Rs.150/-
3.		Rs.120 /-

	University Union Fee (one time payment for two years)	
4.	Students Aid Fund Fee (one time payment for two years)	Rs.60 / -
5.	Student care fund (one time payment for two years)	Rs.200/ -
6.	Women's Study Unit Fee (one time payment for two years)	Rs.30/ -
7	Students Affiliation fee: (one time payment for two years)	Rs. 450/-
TOTAL AMOUNT		Rs: 1030/-

SC/ST/OEC candidates should remit a token amount of Rs.100/- to assure their allotment/ admission. They should also remit the Premium for Student Care Fund of Rs.200/- (onetime payment for two years) along with the token amount, at the time of admission.

The University fee once remitted will not be refunded under any circumstances. The candidates need to remit the University fee only once for admission.

It is advised to keep a copy of payment receipt of registration fee and University admission fee with the candidate for future purpose if any. The payment receipt will not be issued again, after the closure of admission website, under any circumstances.

**10.1** The students who are eligible for scholarship under SC/ST/SEBC/ Fishermen should submit their scholarship form for the academic year, immediately after obtaining admission.

**10.2** Remittance of University admission fee for candidates who get admission other than through allotments (management quota, community quota, sports quota, Lakshadweep quota, admission



through special order etc.) shall also be done in online mode. The candidates shall approach the Principal of the college concerned for enabling the payment link in candidate profile.

## **11. DOCUMENTS TO BE SUBMITTED AT THE TIME OF ADMISSION**

All candidates who take admission in a college shall submit the following documents before the Principal/Head of the College/Institution concerned. No additional time will be granted to the candidates for submitting the documents at the time of admission.

- a. Print out of completed online application.
- b. The original fee receipt / transaction slip towards Registration fee.
- c. The original fee receipt / transaction slip towards University Admission Fee.
- d. Allotment Memo (Latest) in case of candidates who get admission through centralized allotment/spot allotment

OR

Letter duly signed by the Registrar in case of candidates who get admission through special order.

- e. Original mark list/certificate of the qualifying examination.
- f. Certificate to prove date of birth.
- g. TC from the Institution last attended.
- h. Course & Conduct Certificate.
- i. Migration Certificate from the Board/University last studied.
- j. Course Cancellation memo from the University last attended (if applicable) (See clause 7.6)
- k. Certificates from the village officer namely “The applicant belonging to Anthyodaya Anna Yojana (AAY) and Priority House Hold (PHH) category” or “The income or assets certificate for Economically Weaker Sections (EWSs) in General Category” for candidates under EWS in General Category (Format of certificates are given in Annexure XI and Annexure XII)
- l. Caste/Community Certificate for candidates under Scheduled Castes/ Scheduled Tribes quota.
- m. Non Creamy Layer Certificate in the case of SEBC candidates.
- n. Non Creamy Layer Certificate in the case of OEC candidates claiming vacant SC/ST seats.
- o. Non Creamy Layer Certificate/Community Certificate in the case of OEC candidates claiming fee concession.

- p. Community Certificate and Income Certificate in the case of candidates eligible for OEC educational assistance (Annexure V.A)
- q. Original certificates to prove the claim for grace marks/weightage, if any.
- r. Eligibility Certificate from the University of Kerala in case of candidates who have passed qualifying examination from Other Universities.
- s. Transgender identity card from State Government if applicable.
- t. Undertaking from the students as per the provisions of anti-ragging verdict by the Hon'ble Supreme Court of India. (Annexure VII)
- u. Any other relevant certificate for any claim made in the application.

### **SPECIAL INSTRUCTIONS**

1. Failure to report for Admission: Candidates who do not take admission on the prescribed date will lose their allotment. They will not be considered for any further regular allotments under any circumstance.
2. Candidates have the freedom to change their password; however, they should take note of the password and application number carefully for future login.
3. Applications of candidates who do not register their personal and academic data online and who do not give their options online within the time schedule will not be considered for allotment. No opportunity will be given to incorporate any details after the last date of submission of application. Late or defective application will not be considered under any circumstances.
4. Any kind of false information will lead to cancellation of admission.
5. Candidates from other Universities, where the grades are awarded instead of marks, should enter the corresponding marks, while entering the academic data.
6. No rounding of marks / percentage to the nearest whole number will be permitted.
7. The University will not entertain any request for change of the dates of Online Centralized Allotment.
8. Any other item not specifically covered in this prospectus will be decided by the University and that decision shall be final.
9. Preventive measure against ragging: If an applicant for admission is found to have indulged in ragging in the past or if it is noticed later that he/she had indulged in ragging, either he/she will not be admitted or shall be expelled from the educational institution.

**Any disputes pertaining to allotment/ admission shall fall within the jurisdiction of the Hon'ble High Court of Kerala.**

**REGISTRAR**

**UNIVERSITY OF KERALA**

**SH CAMPUS,PALAYAM**

**THIRUVANANTHAPURAM 695 034**

# UNIVERSITY OF KERALA

(Abstract)

Eligibility Criteria and calculation of Index Mark – New PG Programmes for affiliated colleges with effect from 2020 admission onwards - Approved - Orders issued.

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## ACADEMIC A.II SECTION

No.Ac.A.II.3/22543/2020

Dated, Thiruvananthapuram 16.11.2020

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Read:1. Item no.I.01 of the Minutes of the meeting of the Academic Council held on 15/10/2020.  
2. U.O. of even number dated 05.11.2020.

## ORDER

The Academic Council vide paper read as (1) above, resolved to approve the Scheme and Syllabus of the following newly introduced Post Graduate Degree programmes for affiliated colleges with effect from 2020 admission onwards and U.O read as (2) above was issued accordingly.

1. M.Sc. Chemistry with Specialization in Drug Design and Development
2. M.Sc. Geology with Specialization in Geoinformatics
- 3.M.Sc. Physics with Specialization in Space Physics
4. M.Sc. Physics with Specialization in Nanoscience
5. M.Sc. Zoology with Specialization in Biosystematics and Biodiversity
6. M.Sc. Statistics with Specialization in Data Analytics
7. M.Sc. Botany with Specialization in Ethno Botany and Ethno Pharmacology
8. M.A Economics (Behavioural Economics and Data Science)
9. M.A Political Science (International Relations)
10. M.A History (World History and Historiography)
11. M.A Women's Studies
12. M.S.W (Disaster Management)

Candidates seeking admission to the new Post Graduate Degree programmes for affiliated colleges have to satisfy the academic eligibility as described in the following sub clauses as recommended by the Chairmen, Board of Studies/ Deans of Faculties.



## **KSMDB COLLEGE, SASTHAMCOTTA**

### **M. Sc. Degree Program in Physics with Specialization in Nanoscience**

M.Sc. physics with specialization in nanoscience is a government aided post graduate course affiliated to University of Kerala and our premiere institution is eligible for this course due to its academic excellence.

Major objective of this M. Sc. Physics program of University of Kerala is to equip the students for pursuing higher studies and employment in any branches of Physics and related areas. The program also envisages developing thorough and in-depth knowledge in Mathematical Physics, Classical Mechanics, Quantum Mechanics, Statistical Physics, Electromagnetic Theory, Nuclear Physics, Atomic and Molecular Spectroscopy and Electronics. The program also aims to enhance problem solving skills of students so that they will be well equipped to tackle national level competitive exams. The program also acts as a bridge between theoretical knowhow and its implementation in experimental scenario.

The specialization of this M.Sc. Physics program in Nanoscience covers basic ideas of nanostructured materials, Physics of nanosolids and nanoelectronics. This program delivers fundamental ideas of size effect in materials science and propose new applications of nanoscience and nanotechnology. The program also introduces the students about the scientific research approach in defining problems, execution through analytical methods, systematic presentation of results keeping in line with the research ethics through M. Sc. dissertations. It is also helpful in disseminating scientific knowledge and scientific temper in the society to contribute towards greater human cause.

Nanotechnology is the field of science and technology of developing nanoparticles and materials that have the size within the range of nanometers. The physical and chemical properties of matter change at the nano level. Nanotechnology has the potential to revolutionize a diverse range of fields from health care to manufacturing. The manipulation of matter on the nanoscale offers new opportunities to solve scientific challenges in the modern world.

### **Highlights of M.Sc. Physics with specialization in Nanoscience**

- No aided institutions other than our college under Kerala university offers PG courses in Nanoscience. So far nanoscience studies were confined only to institutions like IISc, IIST, IISER, IIT, NIT in India.
- This course provides the students adequate knowledge needed for full appreciation of research and innovation in both Nano-Science and Nanotechnology.
- The field of Nanoscience is multidisciplinary and can connect different branches of Sciences such as Chemistry, Engineering, Robotics, Biology, Medicine or Environment.
- There is an ample opportunity in the field of research and for facilitating researches in Nanoscience and Technology, CSIR has started about thirtyeight laboratories all over India.
- The aim of this master's degree is to train competent professionals in this field, in industrial and scientific aspects. Therefore, students who join the course should be versatile enough to use this knowledge to design and develop new products and

systems that could have a major bearing on a wide range of areas of special socioeconomic significance

## A: COURSE STRUCTURE & MARK DISTRIBUTION

(Effective from 2020 admissions)

Semester	Paper Code	Title of Paper	Contact			UE duration (h)	Maximum marks		
			L	T	P		IA	UE	Total
I	PH211	Classical Mechanics	6	1	...	3	25	75	100
	PH212	Mathematical Physics	6	1	...	3	25	75	100
	PH213	Basic Electronics	6	1	...	3	25	75	100
	PH251	General Physics Practical	...	1	3	...	...	...	...
	PH252	Electronics & Computer Science Practical	...	1	4	...	...	...	...
	Total for Semester I(S1)		18	5	7	...	75	225	300
II	PH221	Modern Optics & Electromagnetic theory	6	1	...	3	25	75	100
	PH222	Thermodynamics, Statistical Physics & Basic Quantum	6	1	...	3	25	75	100
	PH223	Computer Science & Numerical	6	1	...	3	25	75	100
	PH251	General Physics Practical	...	1	3	6	25	75*	100

	PH252	Electronics & Computer Science Practical	...	1	4	6	25	75*	100
	Total for Semester II (S2)		18	5	7	...	125	375	500
III	PH231	Advanced Quantum Mechanics	6	1	...	3	25	75	100
	PH232	Atomic and Molecular Spectroscopy	6	1	...	3	25	75	100
	PH233	Condensed Matter Physics	6	1	...	3	25	75	100
	PHN234	Nanostructured Materials	7	1	...	3	25	75	100
	Total for Semester III (S3)		25	4			100	300	400
IV	PH241	Nuclear & Particle Physics	6	1	...	3	25	75	100
	PHN242	Physics of Nanosolids	5	1	...		25	75	100
	PHN 243	Nanoelectronics	5	1			25	75	100
	PHN244	Lab: Nanoscience	...	...	5	6	25	75*	100
	PHN245	Project	...	...	4	...	25	75	100
	PHN246	Viva voce	...	...	...	...	...	100	100
	Total for Semester IV (S4)		16	3	9	...	125	475	600
Grand Total							425	1375	1800

\*10 marks for records, L-Lecture

T-Tutorial UE-University Exam

IA - Internal Assessment

P-Practical





## **B: SPECIAL COURSES FOR THIRD AND FOURTH SEMESTERS**

<b>Sl. No</b>	<b>Specialization</b>	<b>Code Nos of Special Papers</b>	<b>Name of Special Papers</b>
<b>1</b>	<b>Nanoscience</b>	<b>PHN 234 PHN 242 PHN 243  PHN 244</b>	<b>Nanostructured Materials Physics of Nanosolids Nanoelectronics Lab. Nanoscience</b>

## **C: General guidelines of UGC**

### **C1-Theory papers**

- Books of study and corresponding chapters are given for most of the theory papers in the syllabus to define the scope of the syllabus.
- For internal evaluation of theory papers at least one Viva must be conducted for each paper
- For assignments and seminars current developments in the areas of the syllabus may be chosen for improving the general awareness of the student
- In tutorial sessions of theory papers problem solving in different topics of the syllabus may be discussed.

### **C2-Lab Courses**

- Rough records may be properly maintained for each practical paper and should be produced during the University Practical Examinations along with original record book.
- Each student is encouraged to include critical comments on each

experiment done in the original records including sources and estimates of errors, limitations in the experiments done and scope for improvements/additions in the experimental work.

- In performing Electronics Practical: Bread Board Practice is recommended in addition to soldering of electronic circuits.

### **C3-Project work and Evaluation**

The project work should be carried out in the area of Nanoscience or related areas. The project may be started during the third semester of the M.Sc. programme. 25marks of the project are to be awarded on the basis of internal assessment carried out in the College for each student concerned. A Project rough record may be maintained by each student to help to evaluate the progress of the project. Each student is required to present the completed project along with experimental demonstration if any in the college before the final University examinations in the Fourth Semester of the M. Sc. (Physics) Programme.

For University Examinations for the Project: 50marks is allotted for Project report evaluation and 25 marks allotted for Project based Viva Voce to be conducted along with General Viva Voce examination by the University.

### **D – Pattern of University question papers**

#### **D1- Theory paper**

**Each question Paper has three parts: Part A, Part B and Part C**

**Part A: Eight short answer questions covering the entire syllabus. *One of the questions from this section may be used to test the CURRENT***

*AWARENESS (general knowledge) of the student in the areas of syllabus covered for this paper.*

Each question carries 3 marks.

**Part B: contains three compulsory questions with internal choice.**

**Questions cover all the three units in the syllabus.**

Each question carries 15 marks.

**Part C: contains six problems covering the entire syllabus. The student needs to answer any three. Each question carries five marks.**

**The question paper pattern for the theory papers is given separately.**

### **D1- Practical**

**Each practical paper carries a total of 75 marks.**

**10 marks are allotted for practical records.**

### **PH 251 General Physics Practical (6h):**

**Section A (45 marks) and Section B (20 marks)**

### **PH 252: Electronics and Computer Science (6h):**

**Unit A-Electronics practical (45marks)**

**Unit B- Computer Science (20marks)**

### **PHN 244: Lab: Nanoscience (5h) (65marks)**

### **PHN 245 Project:**



**Internal Evaluation for project is 25 marks**

**For University Examinations: 50marks for Project Dissertation/report evaluation and 25 marks for Project based Viva-Voce**

**PHN 246 General Viva-Voce:**

**For General Viva-Voce covering the entire M.Sc. Syllabus**

**UniversityExaminations:100marks**

**(University Question Paper pattern given separately)**

## **Question Paper Pattern**

**MSc Degree**

**Examination Branch**

**II PHYSICS**

**PH.. 2xy.....**

**Duration: 3 hours**

**Maximum marks: 75**

**Instructions to question paper setter**

- 1. Each question paper has three parts - Part A, Part B and Part C**
- 2. Part A contains eight short answer questions spanning the entire syllabus, of which the candidate has to answer any five question carries three marks.**

3. Part B contains three compulsory questions with internal choice. Each question shall be drawn from each unit of the syllabus. Each question carries 15 marks
4. Part C contains six problems spanning the entire syllabus. The candidate has to answer any three. Each question carries five marks

#### **PART A**

**(Answer any five questions. Each question carries three marks)**

1.

2.

3.

4.

5.

6.

7.

8.

**(5 x 3 = 15 marks)**

#### **PART B**

**Answer three questions each question carries 15 marks**

**9 (a)**

**(b)**

**OR**

**10 (a)**

**(15marks)**

**(b)**

**11 a)**

**(b)**

**OR**

**12 a)**

**(15 marks)**

**b)**

**13a)**

**b)**

**OR**

**14 a)**

**b)**

**(15 marks)**

**Part C**

**(Answer any three questions. Each question carries five marks)**

**16**

**17**

**18**

**19**

**20**

**21**

**(3 x 5= 15 marks)**

## **PH 211: CLASSICAL MECHANICS (6L, 1T)**

**Objectives:** This course is aimed to provide basic and advanced concepts in classical mechanics. The course discusses Lagrangian and Hamiltonian formalisms, central force problems, theory of small oscillations, Hamilton - Jacobi equations, Kepler's problem, Rigid body dynamics and Euler's equations, Concepts of special and general theory of relativity, Non-linear dynamical systems and chaos.

### **Unit I**

#### **Lagrangian Mechanics (12 hours)**

Mechanics of a particle and system of particles- constraints- D'Alembert's principle and Lagrange's equations-simple applications of Lagrangian formulation-Hamilton's principle- techniques of calculus of variations- derivation of Lagrange's equations from Hamilton's principle-conservation theorems and symmetry properties

#### **Two body central force problem (14 hours)**

Reduction to one body problem-equations of motion-equivalent one-dimensional problem- differential equation for the orbit in the case of integrable power law potentials- Virial theorem- Kepler's problem-inverse square law of force-scattering in central force field- transformation of the scattering problem to laboratory coordinates

#### **Theory of small oscillations (10 hours)**

Equilibrium and potential energy-theory of small oscillations-normal modes- two coupled pendula- longitudinal vibrations of carbon dioxide molecule

### **Unit II**

#### **Hamiltonian Mechanics (12 hours)**

Generalized momentum and cyclic coordinates-conservation theorems-Hamilton's equations- examples in Hamiltonian dynamics (harmonic oscillator, motion of a particle in a central force field, charged particle in an



electromagnetic field, compound pendulum)- canonical transformations- generating functions- Poisson brackets- Liouville's theorem

#### **Hamilton-Jacobi equations (10 hours)**

Hamilton-Jacobi equation-harmonic oscillator as an example-separation of variables in Hamilton-Jacobi equation-action angle variables-Kepler's problem

#### **Rigid body dynamics (14 hours)**

Generalized coordinates of rigid body-Euler's angles- infinitesimal rotations as vectors-angular momentum and inertia tensor- Euler's equations of motion of a rigid body-force free motion of symmetrical top-motion of heavy symmetrical top.

#### **Unit III**

#### **Special and General Theory of Relativity (16 hours)**

Postulates of special theory- four-vectors and tensors- relativistic particle dynamics- Lorentz transformations -relativistic Lagrangian- mass-energy equivalence- covariant Lagrangian, Relativistic Lagrangian, Mass energy equivalence.

General theory of relativity principle of equivalence applications - ideas of Riemannian geometry-space time curvature geodesics -Einstein's equations of General theory of relativity, Observational evidence to general theory of relativity.

#### **Introduction to non-linear dynamics (10 hours)**

Linear and nonlinear systems-integration of second order non-linear differential equations- pendulum equation-phase plane analysis of dynamical systems-linear stability analysis-limit cycles

#### **Elements of classical chaos (10 hours)**

Bifurcation- logistic map-strange attractors- Lyapunov exponent and Chaos- ideas of fractals- solitary waves- Kdv equations and solutions

#### **Course Outcome**

- (i) Students are able to learn the concepts of Lagrangian and Hamiltonian mechanics and use them to solve problems in mechanics. Able to learn concepts of generating functions, Poisson brackets Hamilton Jacobi equations and action angle variables.
- (ii) To equip the students to deal with central force problem and analyzing Kepler's laws.
- (iii) To inculcate the students the concepts of special and general theory of relativity and related problems.
- (iv) To acquaint the students about the theory of small oscillations and Euler's equations of motions of rigid bodies.
- (v) To analyze nonlinear dynamical systems and to explain the concepts of classical chaos.

#### **Books for study**

1. H. Goldstein, C. Poole and S. Safko, Classical Mechanics, 3rd Edn, Pearson Education Inc (2008 Print)
2. V. B. Bhatia, Classical Mechanics with introduction to nonlinear oscillations and chaos, Narosa Publishing House (1997)
3. J. C. Upadhyay, Classical Mechanics, Revised Edition, Himalaya Publishing Company (2005)
4. G. Aruldas, Classical Mechanics, Prentice Hall of India Pvt Ltd (2008 Print)
5. K. D. Krori, Fundamentals of Special and General Relativity, PHI Learning Pvt Ltd (2010)
6. S. K. Srivastava, General Relativity and Cosmology, PHI learning Pvt Ltd (2008)
7. P. G. Drazin and R.S Johnson, Solitons – an Introduction, Cambridge University Press (1989)
8. References
9. N. C. Rana and B.S. Joag, Classical Mechanics, Tata Mc Graw Hill (1991)

10. **M. Tabor Chaos and integrability in nonlinear dynamics, John Wiley & Sons (1989)**
11. **R. K. Pathria, The Theory of Relativity, Second Edition, Over Publications (2003)**

### **PH 212: MATHEMATICAL PHYSICS (6L, 1T)**

**Objectives:** This course is aimed to equip the students with the mathematical techniques used for developing strong back ground in the basic and advanced level problems. The course describes about curvilinear coordinates, Fourier series and transforms, probability distributions, partial differential equations and different integral transforms, special functions, tensors and group theory.

#### **Unit I**

##### **Vector analysis and matrices (8 hours)**

**Review of vector analysis-vector calculus operators-orthogonal curvilinear coordinates- gradient, divergence, curl, Laplacian in cylindrical and spherical polar coordinates- orthogonal and unitary matrices- Hermitian matrices- diagonalization of matrices- normal matrices- Cayley-Hamilton theorem**

##### **Complex analysis (8 hours)**

**Cauchy-Riemann conditions-Cauchy's integral theorem and formula-singularities and mapping- calculus of residues-dispersion relations**

##### **Fourier series and applications (8 hours)**

**General principles of Fourier series, Complex representation, Parseval's identity, Fourier's Integrals, Fourier transforms and its properties.**

##### **Probability (12 hours)**

**Definitions and simple properties of probability-random variables- Chebyshev inequality and moment generating function-discrete and continuous probability distributions-binomial distributions- Poisson distributions- Gauss Normal distribution-error analysis and least square fitting-chi-square and student 't' distributions**

## **Unit II**

### **Differential equations (16 hours)**

Partial differential equations-first order equations-separation of variables-singular points-series solutions and Frobenius method- non-homogeneous partial differential equations-Green's functions-Laplace transforms and inverse Laplace transforms-applications to solution of simple differential equations

### **Special functions (20 hours)**

Bessel functions of the first kind-orthogonality-Neumann functions-Hankel functions-modified Bessel functions-spherical Bessel functions-Legendre functions-generating function-recurrence relations and orthogonality-associated Legendre functions-spherical harmonics-Hermite functions-Laguerre -functions Chebyshev polynomials-hypergeometric functions

## **Unit III**

### **Tensor analysis (18 hours)**

Notations and conventions in tensor analysis-Einstein's summation convention-covariant and contravariant and mixed tensors-algebraic operations in tensors-symmetric and skew symmetric tensors-tensor calculus- Christoffel symbols-kinematics in Riemann space-Riemann- Christoffel tensor.

### **Group theory (18 hours)**

Definitions of a group-elementary properties-sub groups-homomorphism and isomorphism of groups-representation of groups-reducible and irreducible representations-simple applications in crystallography and molecular symmetry- Lie groups- SU (2) groups and their representations

## **Course Outcome**

- (i) To apply and analyze the various vector and matrix operations and to perform complex analysis for solving physical problems.



- (ii) To demonstrate and utilize the concepts of Fourier series and its transforms.
- (iii) To explain and differentiate different probabilistic distributions.
- (iv) To apply partial differential equations and special functions for solving mathematical problems.
- (v) To illustrate and apply concepts of group theoretical operations and tensors.

#### **Books for study**

1. G. B. Arfken and H.J. Weber, *Mathematical methods for Physicists*, 6<sup>th</sup> Edition, Elsevier (2005).
2. H. K. Dass and R. Verma, *Mathematical Physics*, S. Chand & Co Pvt Ltd (1997)
3. A.W. Joshi, *Matrices and Tensors in Physics*, 3rd Edition, New Age International Pub (1995)
4. B. D. Gupta, *Mathematical Physics*, 4th Edition, Vikas Publishing House (2004)
5. A. W. Joshi, *Elements of Group Theory for Physicists*, Fourth Edition, New Age International Pub (1997).
6. S. C. Bagchi, S. Madan, A. Sitaram V. B Tewari, *A first course in representation theory and linear Lie groups*, University Press (India) Pvt Ltd (2000).
7. C. Harper, *Introduction to Mathematical Physics*, Prentice Hall (1986)

#### **References**

1. Harry Lass, *Vector and Tensor Analysis*, McGraw Hill Pub (1950)
2. M. L. Jain, *Vector Spaces and Matrices in Physics*, Alpha Science International (2001)
3. W. W. Bell, *Special Functions for Scientists and Engineers*, Dover Publications (2004)
4. W. K. Tung, *Group theory in Physics*, World Scientific Pub Co (1999)
5. A. K. Ghatak, I. C. Goyal and S. T. Chua, *Mathematical Physics*,

**Macmillan India (1985)**

**PH 213: BASIC ELECTRONICS (6L,1T)**

**Objectives:** This course is aimed to introduce the students with the basic knowledge of analog and digital circuits. The course illustrates the concepts of various amplifier circuits, solid state electronic devices, sequential digital circuits, optoelectronics devices and measurements using electronic instruments.

**Unit I**

**Selections from electronic circuits (10 hours)**

**Frequency response of an amplifier circuits-power and voltage gain-impedance matching-Bode plots- Miller effects- rise time bandwidth relations-frequency analysis of BJT and FET amplifier stages**

**Operational amplifier and its applications (18 hours)**

**Opamp - frequency response, poles and zeroes, transfer functions (derivation not required), expression for phase angle- Active filters-first order and second order Butterworth transfer function-first order and second order active filters- low pass, high pass and band pass filters- comparators-OP Amp as a voltage comparator-zero crossing detectors-Schmitt trigger-voltage regulators- square, triangular and saw tooth wave form generators-Weinberg oscillator- monostable and astable multivibrator circuits using IC 555 timer-Phase Locked Loop circuits (PLL)**

**Microwave solid state electronic devices (8 hours)**

**Tunnel diode-varactor diode-IMPATT diode- QWITT diode- TRAPATT diode- Gunn diode**

**Unit II**

## **Digital electronics**

### **Arithmetic and data processing digital circuits (16 hours)**

Binary adder and subtractor- arithmetic logic unit- binary multiplication and division- arithmetic circuits using HDL- multiplexers- demultiplexers- BCD to decimal decoder- seven segment decoder- parity generators and checkers- magnitude comparator- programmable logic arrays

### **Sequential digital circuits (20 hours)**

Flip flops- edge triggered- SR flip flops- JK flip flop- D- flip flop- JK master-slave flip flop- different types of registers (SISO, SIPO, PISO, PIPO)- universal shift registers- applications- counter asynchronous and synchronous electronic counters- decade counters-digital clock.

## **Unit III**

### **Optoelectronics (22 hours)**

Optical fibre as a wave guide-mode theory of circular wave guide- -modes in step index fibres- signal distortion in optical fibres- group delay, material dispersion, wave guide dispersion- sources of attenuation- absorption, scattering, bending loss, core and cladding loss- optical sources- LED's- structure, quantum efficiency and power- laser diodes- modes and threshold conditions, rate equations, efficiency and resonant frequency- photo detector- pin and avalanche photodiodes- principles- optical amplifier- basic applications and types, semiconductor optical amplifiers, erbium doped fibre amplifiers.

### **Electronic Instrumentation (14 hours)**

Electronic measurements and instruments-comparison between analog and digital instruments- performance and dynamic characteristics-ideas of errors and measurement standards- voltmeters-ammeters- CRO- Block diagram, CRT, CRT circuits, vertical deflection system- delay line, multiple trace, horizontal deflection system, oscilloscope probes and transducers, oscilloscope techniques, storage oscilloscope, digital storage oscilloscope- classification of transducers- active and passive transducers-force and displacement transducers-strain gauges- temperature measurements-thermistors-thermocouples-flow

**measurements.**

**Course Outcome**

- (i) To equip the students design and analyze different analogue and digital circuits.**
- (ii) To summarize the knowledge of basic arithmetic and data processing circuits and memory devices.**
- (iii) To equip the students to explain various components in optical communications systems and microwave devices.**
- (iv) To measure and analyze the different electronic signals.**

**Books for study**

- 1. A. Malvino and D. J. Bates, Electronics Principles, 7th Edition, Tata McGraw Hill (2007)**
- 2. R. A. Gayakwad, Operational Amplifiers and Linear integrated Circuits, Prentice Hall of India (2000)**
- 3. M. S. Tyagi, Introduction to semiconductor materials and devices, Wiley India (2005)**
- 4. B. G. Streetman, S.K. Banerjee, Solid state electronic devices. Pearson Inc (2010)**
- 5. J. Millman, C. Halkias and C.D. Parikh, Integrated Electronics, Tata McGraw Hill (2010)**
- 6. D. P. Leach, A. P. Malvino, and G. Saha, Digital principles and applications, Tata McGraw Hill (2011)**
- 7. G. Keiser, Optical Fibre Communication, 3rd Edn., McGraw Hill Pub (2000)**
- 8. Lal Kishore, Electronic measurements and Instrumentation, Dorling Kindersley (India) Pvt Ltd (2010)**
- 9. W. D. Cooper, A. O. Helfrik and H. Albert, Electronic Instrumentation and measurement Techniques, PHI (1997)**



10. **Electronic Devices and Circuits Theory, Robert L. Boylestad, Louis Nashelsky, Pearson 10<sup>th</sup> edition (2009)**

#### **References**

1. **T. F. Bogart Jr, J. S. Beasley and G. Reid, Electronic devices and circuits, Sixth Edition, Pearson Inc (2004)**
2. **Thomas. L. Floyd, Digital Fundamentals, 10th edition, Dorling Kindersley (India) Pvt Ltd (2011)**
3. **Joachion Piprek, Semiconductor Optoelectronic Devices, Academic Press (2003)**

#### **PH 221: MODERN OPTICS AND ELECTROMAGNETIC THEORY (6L, 1T)**

**Objectives: This course covers linear and non-linear optical phenomenon, propagation of electromagnetic waves, relativistic electrodynamics, radiation and antenna theory.**

#### **Unit I**

##### **Modern optics (24 hours)**

**Multiple beam interference-Fabry-Perot interferometer- theory of multilayer films-antireflection films and high reflectance films -Fresnel- Kirchoff integral theorem and formula- Fraunhofer and Fresnel diffraction patterns and theory- applications of Fourier transforms to diffraction- acoustic- optic modulation- basic ideas of Raman-Nath diffraction and Bragg diffraction- holography as wavefront reconstruction-propagation of light in crystals-optical activity and Faraday rotation**

### **Non-linear optics (12 hours)**

Harmonic generation- second harmonic generation- phase matching- third harmonic generation- optical mixing- paramagnetization of light- self focusing- multiquantum photoelectric effect- two photon process and theory- multiphoton processes- three photon processes- second harmonic generation- parametric generation of light.

### **Unit II**

### **Electromagnetic waves (12 hours)**

Electromagnetic wave equations-electromagnetic waves in non-conducting media-plane waves in vacuum-energy and momentum of electromagnetic waves-propagation through linear media- reflection and transmission at normal and oblique incidence-electromagnetic waves in conductors-modified wave equations and plane waves in conducting media-reflection and transmission at a conducting interface

### **Relativistic electrodynamics (14 hours)**

Vector and scalar potential- gauge transformations- Coulomb gauge and Lorentz gauge- Magnetism as a relativistic phenomena- transformation of the field- electric field of a uniformly moving point charge-electrodynamics in tensor notation-electromagnetic field tensor-potential formulation of relativistic electrodynamics

### **Radiation (10 hours)**

Dipole radiation- electric dipole radiation- magnetic dipole radiation- radiation from an arbitrary source- point charges- power radiated by a point charge- radiation reaction

### **Unit III**

### **Transmission lines (12 hours)**

Transmission line parameters and equations-input impedance-standing wave ratio and power- The Smith Chart-applications of transmission lines

### **Waveguides (12 hours)**

**Rectangular wave guides-transverse magnetic (TM) modes-Transverse electric (TE) modes- wave propagation in the wave guide-power transmission and attenuation**

**Antennas (12 hours)**

**Radiation from Hertzian dipole-half wave dipole antenna-quarter wave monopole antenna- antenna characteristics -antenna arrays-effective area and Friji's equations**

**Course Outcome**

- (i) To demonstrate the linear and nonlinear optical phenomena.**
- (ii) To explain and discuss propagation of electromagnetic waves through different media.**
- (iii) To restate formulations and relativistic effects in electrodynamics.**
- (iv) To analyse the propagation of electromagnetic waves through waveguides.**
- (v) To use radiation theory in developing different antennas.**

**Books for study**

- 1. G.R. Fowles, Introduction to Modern Optics, Second Edition, Dover Publications (1989)**
- 2. A. Yariv, Introduction to Optical electronics, Holt, Reinhart and Winston (1976)**
- 3. A. Ghatak and K. Thyagarajan, Optical Electronics, Cambridge University Press (1998)**
- 4. D. Roody and J. Coolen, Electronic Communications, Fourth Edition, Dorling Kindersley (India) Pvt Ltd (2008)**
- 5. D. J. Griffiths, Introduction to Electrodynamics, PHI Learning India Pvt Ltd (2007)**
- 6. M. N. O. Sadiku, Elements of electromagnetics, Oxford University Press (2007)**
- 7. B. B. Laud, Lasers and Non-linear Optics, Second Edition, Wiley-Eastern Limited (1991)**

## **References**

1. **J.R. Meyer-Arendt, Introduction to Classical and Modern Optics, Prentice Hall Intl (1995)**
2. **J.C. Palais, Fibre optic communications, Fifth Edition, Pearson Education Inc (2005)**
3. **E.C. Jordan and K.G. Balmain, Electromagnetic waves and radiating systems, Second Edition, Pearson Education (2002)**
4. **D. K. Cheng, Field and Wave electromagnetics, Second Edition, Addison Wesley (1999).**
5. **L. Ganesan and S. S. Sreejamole, Transmission lines and wave guides, Second Edition, Tata McGraw Hill (2010)**

## **PH 222: THERMODYNAMICS, STATISTICAL PHYSICS AND BASIC QUANTUM MECHANICS (6L, 1T)**

**Objectives:** This course is aimed to introduce the concepts of thermodynamic equations, foundations of classical and quantum statistics, theory of phase transitions and foundations quantum mechanics together with problems.

### **Unit I**

#### **Thermodynamic relations and consequences (20 hours)**

**Thermodynamic functions and Maxwell's equations-Clausius-Clapeyron's equations- Properties of thermodynamic potentials-Gibbs-Helmholtz relation-thermodynamic equilibrium- Nernst –heat theorem and its consequences- Gibb's phase rule-chemical potential-vapor pressure relation and chemical constants**

#### **Foundations of classical statistical physics (16 hours)**

**Phase space-ensembles-Lioville's theorem-statistical equilibrium-microcanonical ensemble- partition functions and thermodynamic quantities- Gibb's paradox-Maxwell-Boltzmann distribution laws-grand canonical**

ensemble

## Unit II

### Quantum statistics (26 hours)

Quantum statistics of classical particles-density matrix in microcanonical, canonical and grand canonical ensembles-Bose Einstein statistics and Bose Einstein distribution law-Maxwell Boltzmann statistics and Maxwell Boltzmann distribution law—Fermi Dirac statistics and Fermi Dirac distribution law-comparison of three types of statistics-applications of quantum statistics-Planck radiation laws-Bose Einstein gas and Bose Einstein condensation—Fermi Dirac gas-electron gas in metals-thermionic emission-statistical theory of white dwarfs

### Phase transitions (10 hours)

Triple point-Van der waal's equation and phase transitions-first and second order phase transitions- Ehrenfest's equations- Ising model

## Unit III

### Foundations of quantum mechanics (14 hours)

Basic postulates of quantum mechanics- Hilberts space- observables- Hermitian operators- general statistical interpretation-Uncertainty principle-minimum uncertainty wave packet- energy time uncertainty principle-Dirac notation-Matrix representation of state vectors and operators-change of representations- eigenvalue problem in matrix mechanics-energy and momentum representations-unitary transformations involving time- Schrodinger, Heisenberg and interaction pictures.

### Exactly solvable problems in quantum mechanics (22 hours)

One dimensional eigen value problems-square well potential-potential barrier-alpha particle emission-Bloch waves in periodic potential-linear harmonic oscillator problem using wave mechanics and operator methods-free particle wave functions and solutions-three dimensional eigen value



**problems-particle moving in spherical symmetric potential-rigid rotator-  
hydrogen atom problem-three dimensional potential well- Deuteron**

### **Course Outcome**

- (i) To explain the basic thermodynamic relations, Maxwell's equations and its consequences.**
- (ii) To equip the students to demonstrate and apply classical and quantum statistics in different physical phenomena.**
- (iii) To distinguish the different phase transitions using Ising model.**
- (iv) Outline and apply foundations of quantum mechanics.**

### **Books for study**

- 1. R. K. Pathria, *Statistical Mechanics*, Pergamon Press (1991)**
- 2. Satya Prakash, *Statistical Mechanics*, Kedarnath Ram Nath Publishers, Meerut and Delhi (2009)**
- 3. B.K. Agarwal and Hari Prakash, *Quantum Mechanics*, Prentice Hall of India (2002)**
- 4. S. Devanarayanan, *Quantum Mechanics*, Sci Tech Publications (India) Pvt. Ltd. (2005)**
- 5. D.J. Griffiths, *Introduction to Quantum Mechanics*, Second Edition, Pearson Education Inc ((2005)**
- 6. G. Aruldas, *Quantum Mechanics*, Second Edition, PHI learning Pvt Ltd (2009).**
- 7. J. J Sakurai , *Modern Quantum Mechanics*, Second edition, Pearson (2010).**
- 8. N. Zettili, *Quantum Mechanics concepts and Applications*, Second edition, Wiley (2009).**

### **References**

1. **R. K. Srivastava and J. Asok, Statistical Mechanics, Wiley Easter Ltd (2005)**
2. **S.K. Sinha, Statistical Mechanics-Theory and Applications, Tata Mc Graw Hill**
3. **P.M. Mathews and K.Venkitesan, A Text Book of Quantum Mechanics, Tata Mc Graw Hill (2010)**
4. **A. Ghatak and S. Lokanathan ,Quantum Mechanics Theory and Applications, Kluwer Academic Publishers (2004).**
5. **V.K. Thankappan, Quantum Mechanics, Second Edition, New Age International Pvt Ltd (2003).**

### **PH 223: COMPUTER SCIENCE AND NUMERICAL TECHNIQUES (6L, 1T)**

**Objectives:** This course provides introduction to computer architecture, microprocessors, programming in python and C++ and computational numerical methods.

#### **Unit I**

##### **Foundations of computer science (12 hours)**

**Introduction to computers-computer architecture-memory (RAM and ROM, cache) and storage- I/O devices- operating systems-data communications, computer networks and topology**

##### **Introduction to microprocessors (12 hours)**

**Evolution of microprocessors-microcontrollers and digital signal processors- Intel 8085 8 bit microprocessor- pin description-functional description- 8085 instruction format-addressing modes of 8085- interrupts of 8085- memory interfacing- 8085 machine cycles and Bus timings- assembly language programming of 8085**

##### **Introduction to Python Programming (12 hours)**

**Python - Python shell, number, variables, comparisons and logic, Python objects  
- strings, lists, tuples, loops; control flow, file input and output functions**

## **Unit II**

### **Programming with C++ (36 hours)**

**C++- flow control-conditional statements-iterative statements-switch statements-conditional operators as an alternative to IF-nested loops-break statements-ext( ) functions-structured data types-arrays-storage classes-multidimensional arrays-sorting of strings-functions-built in and user defined- accessing function and passing arguments to functions-calling functions with arrays-scope rule for functions and variables-structures in C++-classes and objects –definition- class declaration-class function definitions-creating objects-use of pointers in the place of arrays-file handling in C++-basic file operations-serial and sequential files-reading and writing on to disks.**

## **Unit III**

### **Numerical Techniques (36 hours)**

**Solution of simultaneous linear algebraic equations-Gauss elimination method-Gauss Jordan method-inverse of a matrix using Gauss elimination method-Finite differences-forward and backward differences-central differences-difference of a polynomial-error propagation in difference table-Interpolation with equal intervals-Gregory Newton forward and backward formula- error in polynomial interpolation-central difference interpolation formula-Gauss's forward and backward formula- Stirling's formula-Lagrange interpolation formula-numerical differentiation-numerical integration using general quadrature formula-Trapezoidal rule- Simsons 1/3 and 1/8 rules-numerical solutions to ordinary differential equations-Euler and modified Euler methods-Runge Kutta methods-numerical solution to partial differential equations-solutions to Poisson and Laplace equations.**

## **Course Outcome**

- (i) To summarize computer hardware and its operating systems**

- (ii) Explain internal architecture of microprocessors 8085 and create assembly language programing.
- (iii) To develop and compile programs in python and C++.
- (iv) Apply numerical methods to solve physical problems.

#### **Books for study**

1. ITL Education Solutions Ltd, *Introduction to Computer Science*, Second Edition, Dorling Kindersley (India) Pvt Ltd (2011)
2. V. N. Vedamurty and N. Iyengar, *Numerical Methods* Vikas Publishing Pvt Ltd (1998)
3. K. Udayakumar, and B.S. Umasankar, *The 8085 microprocessor*, Dorling Kindersley (India) Pvt Ltd (2008)
4. Christian Hill, *Learning Scientific Programming with Python*, Cambridge University Press (2015)
5. V. Carl Hamacher, Z. G. Vranesic and S.G. Zaky, *Computer Organization*, Fourth Edition, McGraw Hill International Edition (1996)
6. Peter Norton et al., *Beginning Python*, Wiley Publishing (2005)
7. Abishek Yadav, *Microprocessor 8085 8086*, University Science Press, New Delhi (2008)
8. D. Ravichandran, *Programming in C++*, Tata McGraw Hill (2011)
9. M. T. Somasekhara, *Programming in C++*, PHI Pvt Publishing (2005).
10. B. Ram, *Fundamentals of Microprocessors and Microcontrollers*, Dhanpat Rai Publications (2008).
11. 11. S. S. Sastry, *Introductory method of Numerical analysis*, Fifth Edition, PHI (2012).

#### **References**

1. V. Rajaraman, *Fundamentals of Computers*, Fifth Edition, PHI (2010)
2. R. S. Gaonkar, *Microprocessor-Architecture, Programming and*

### **Applications with 8085**

- 3. S. S. Sastry, Introductory method of Numerical analysis, Fifth Edition, PHI**
- 4. P. Ghosh, Numerical Methods with computer programs in C++, PHI learning Pvt Ltd**
- 5. Bjarne Stroustrup, The C++ Programming Language, Fourth Edition, Addison Wesley**

### **PH231: ADVANCED QUANTUM MECHANICS (6 L, 1 T)**

**Objectives:** This course describes a thorough conceptual understanding of advanced quantum mechanics covering variation method, WKB approximation, perturbation theory, symmetry and conservation laws, theory of scattering, system of identical particles, angular momentum and relativistic quantum mechanics.

#### **Unit I**

##### **Variation method (6 hours)**

**The variational principle-Rayleigh Ritz method-variation method for excited states-ground state of Helium and Deuteron.**

##### **WKB approximation (8 hours)**

**WKB method-connection formulas-barrier potential-penetration-alpha particle emission-bound states in a potential well**

##### **Time dependent and time-independent perturbation theory (22 hours)**

**Time independent perturbation- basic concepts- non-degenerate energy levels- anharmonic oscillator- ground state of helium- effect of electric field on the ground state of hydrogen- degenerate energy levels- effect of electric field on the  $n=2$  state of hydrogen- spin-orbit interaction.**



Time dependent perturbation- first order, harmonic, transition to continuous states, absorption and emission of radiation- Einstein's coefficients- selection rules.

## **Unit II**

### **Symmetry and conservation laws (10 hours)**

Symmetry transformations-space translation and conservation of angular momentum-time translation and conservation of energy-rotation in space and conservation of angular momentum-space inversion-time reversal

### **Quantum theory of scattering (12 hours)**

Scattering cross section and scattering amplitude-partial wave analysis and scattering by a central potential-scattering by attractive square well potential-scattering length-expression for phase shifts-Born approximation-scattering by Coulomb potential-Laboratory and centre of mass coordinate transformations.

### **System of identical particles (14 hours)**

Identical particles- Pauli's exclusion principle-inclusion of spin-spin function for a two electron system-Helium atom-central field approximation-Thomas Fermi model of an atom-Hartree and Hartree-Fock equations.

## **Unit III**

### **Angular momentum (12 hours)**

Angular momentum in operators and commutation relations-eigen values and eigen functions of  $L^2$  and  $L_z$  –general angular momentum-eigen values of  $J^2$  and  $J_z$ -angular momentum matrices-spin angular momentum –spin vectors for a spin  $1/2$  system-addition of angular momentum-Clebsch-Gordan coefficients.

### **Relativistic quantum mechanics (24 hours)**

Klein-Gordon equations and its relevance-particle in a Coulomb's field-Dirac's relativistic theory-Dirac's equation for a free particle-Dirac matrices-covariant

**form of Dirac's equations-probability density-plane wave solutions-negative energy starts-spin in Dirac's theory-magnetic moment of an electron-relativistic corrections of Hydrogen atom spectrum-spin orbit correction-Lamb shift**

### **Course Outcome**

- (i) To extend the use of approximation methods viz variation, WKB, time dependent and time independent perturbations.**
- (ii) To summarize different types of symmetry, conservation laws and quantum theory of scattering.**
- (iii) To distinguish different approximation methods, to study the structure and properties of many electron systems.**
- (iv) To compute eigen values of angular momentum and evaluation of CG coefficients.**
- (v) Infer the requirements of relativistic quantum mechanics.**

### **Book for study**

- 1. G. Aruldas, *Quantum Mechanics*, Second Edition, PHI learning Pvt Ltd (2009)**
- 2. D. J. Griffiths, *Introduction to Quantum Mechanics*, Second Edition, Pearson Education Inc (2005)**
- 3. J. J. Sakurai, *Advanced Quantum Mechanics*, Pearson Education Inc (2009).**

### **References**

- 1. P. M. Mathews and K. Venkitesan *A Text Book of Quantum Mechanics*, Tata Mc Graw Hill (2010)**
- 2. A. Ghatak and S. Lokanathan, *Quantum Mechanics Theory and Applications*, Kluwer Academic Publishers (2004)**
- 3. V. K. Thankappan, *Quantum Mechanics*, Second Edition, New Age International Pvt Ltd (2003)**

4. S. Devanarayanan, Quantum Mechanics, Sci Tech Publications ( India) Pvt Ltd ( 2005)
5. L. H. Ryder, Quantum Field Theory Second Edition, Cambridge University Press (1996)
6. Steven Weinberg, Quantum Theory of Fields (in Three Volumes), Cambridge University Press (2002)

### **PH 232: ATOMIC AND MOLECULAR SPECTROSCOPY (6L, 1T)**

**Objectives:** This course provides an overview of symmetry of molecules, concepts of atomic spectra, Photoelectron and photo acoustic spectroscopy, Rotational, vibrational, electronic, Raman, Mossbauer, nuclear and electron spin resonance spectroscopic techniques.

#### **Unit I**

##### **Atomic Spectroscopy (14 hours)**

Spectra of Atoms - Spectroscopic terms– selection rules– exchange symmetry of wave functions- Pauli’s exclusion principle. Many electron atoms- Building principle- the spectra of Li and hydrogen like elements, The L-S and j-j coupling schemes- total angular momentum – term symbols- The spectra of Helium- Zeeman effect – The magnetic moment of atom, Lande’s g factor- The normal Zeeman effect- Emitted frequencies in anomalous Zeeman transitions- Nuclear spin and Hyperfine structure, Stark Effect, Paschen Bach effect

##### **Molecular symmetry (10 hours)**

Symmetry operations-symmetry elements-algebra of symmetry operations-multiplication tables-matrix representation of symmetry operators-molecular point groups-reducible and irreducible representations-great orthogonality theorem-character tables for C<sub>2v</sub> and C<sub>3v</sub> point groups, symmetry species of

point groups-IR and Raman activity

**Photoelectron and Photo-acoustic spectroscopy (12 hours)**

Photoelectron spectroscopy-experimental methods-photoelectron spectra and their interpretation-Auger electron and X ray Fluorescence spectroscopy-Photo-acoustic effect-basic theory-experimental arrangement-applications.

**Unit II**

**Molecular rotational Spectroscopy**

**(12hours)**

Classification of molecules-rotational spectra of diatomic molecules-isotope effect and intensity of rotational lines-non rigid rotator-linear polyatomic molecules-symmetric and asymmetric top molecules-microwave spectrometer-analysis of rotational spectra.

**IR Spectroscopy (12 hours)**

Vibrational spectra of diatomic molecules-characteristic IR spectra-vibrations of polyatomic molecules- anharmonicity- Fermi resonance-hydrogen bonding-normal modes of vibration in a crystal- interpretation of vibrational spectra- IR spectrometer- Fourier transform IR spectroscopy

**Electronic spectra of molecules (12 hours)**

Vibrational coarse structure and analysis of bound systems- Deslanders table-Frank-Condon principle-vibrational electronic spectra-rotational fine structure-Fortrat parabola-electronic angular momentum in diatomic molecules

**Unit III**

**Raman spectroscopy (12 hours)**

Theory of Raman scattering-rotational and vibrational Raman spectra-Raman spectrometer-structure determination using Raman and IR spectroscopy-

**nonlinear Raman effects-Hyper Raman effect- stimulated Raman scattering-coherent anti-stokes Raman scattering**

**ESR and NMR Spectroscopy (16 hours)**

**Principle of NMR-ESR spectrometer-Hyperfine structure-ESR spectra of Free radicals- Magnetic properties of nuclei-resonance condition-NMR instrumentation-chemical shift-NMR spectra of solids-NMR imaging-interpretation of NMR spectra**

**Mossbauer spectroscopy (8 hours)**

**Recoilless emission and absorption-Mossbauer spectrometer-experimental techniques-isomer shift- quadrupole interaction-magnetic hyperfine interaction**

**Course Outcome**

- (i) Explain different symmetry operations and deduction of molecular structure.**
- (ii) Distinguish and classify the different spectra shown by atoms and molecules**
- (iii) Illustrate the various spectroscopic experimental techniques.**

**Books for study**

- 1. J.M. Hollas, *Modern Spectroscopy*, Fourth Edition, John Wiley & Sons (2004)**
- 2. G. Aruldas, *Molecular Structure and Spectroscopy*, PHI learning Pvt Ltd (2007)**
- 3. Suresh Chandra, *Molecular Spectroscopy*, Narosa Publishing Co (2009)**
- 4. H E White, *Introduction to Atomic Spectroscopy* McGraw-Hill Inc. 1st Edition. (1934).**

**References**



1. C.N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, Fourth edition, Tata McGraw Hill (1995).
2. D.N. Satyanarayana, Vibrational spectroscopy-Theory and applications, New Age International Pvt Ltd (2004)
3. J. L. McHale, Molecular Spectroscopy, Pearson education Inc (2008).

### **PH 233: CONDENSED MATTER PHYSICS (6L, 1T)**

**Objectives:** To understand and familiarize fundamentals of crystals, lattice vibrations, band theory, dielectric, magnetic and superconducting properties of materials. To introduce the synthesis and characterization techniques of nanomaterials.

#### **Unit I**

##### **Crystal physics (10 hours)**

Lattice points and space lattice-basis and crystal structure-unit cells and lattice parameters- symmetry elements in crystals –space groups-Bravais lattice-density and lattice constant relation-crystal directions, planes and Miller indices-reciprocal lattice-allotropy and polymorphism in crystals-imperfections in crystals.

##### **Lattice vibrations and thermal properties (10 hours)**

Dynamics of identical atoms in crystal lattice-dynamics of linear chain-experimental measurement of dispersion relation-anharmonicity and thermal expansion-specific heat of solids-classical model-Einstein's model-Debye model-thermal conductivity of solids-role of electrons and phonons-thermal resistance of solids.

##### **Free electron and band theory (16 hours)**

Electrons moving in one dimensional potential well-Fermi-Dirac statistics-effect

of temperature on Fermi distribution-electronic specific heat-electrical conductivity of metals- Wiedmann- Franz- Lorentz law-electrical resistivity of metals-Hall effect-energy bands in solids-Kronig- Penny model-construction of Brillouin zones-nearly free electron model-conductors, semiconductors and insulators-elementary ideas of Fermi surfaces

## **Unit II**

### **Semiconductors (12 hours)**

Free carrier concentration in semiconductors-mobility of charge carriers-temperature effects- electrical conductivity of semiconductors-Hall effect in semiconductors - semiconductor junction properties.

### **Dielectric and magnetic properties of materials (24 hours)**

Dipole moment-polarisation-local electric field in an atom-dielectric constant and its measurement-polarizability-classical theory-Peizo, Pyro and Ferro electric properties of Crystals-Ferroelectric domains-classification of magnetic materials-atomic theory of magnetism- Langevin's theory-paramagnetism and quantum theory-Weiss molecular exchange field-ferromagnetic domains-anti ferromagnetism-Ferrites.

## **Unit III**

### **Superconductivity (20 hours)**

Experimental attributes to superconductivity-critical temperature, critical current and critical magnetic field of superconductors-effects of magnetic field on superconductors-Type I and II superconductors-intermediate and vortex states-thermal conductivity, specific heat and energy gap in superconductors-microwave and IR properties-coherence length-Theories of superconductivity-London equations-Ginzberg-Landau theory-BCS theory-AC and DC Josephson effects in superconductors- Examples and properties of High Temperature

## **Superconductors.**

### **Introduction to nano science and technology (16 hours)**

**Introduction to nanomaterials, properties, classification of nanomaterials, quantum confinement effects, Density of states-nano material preparation techniques-sputtering-chemical vapor deposition-pulsed laser deposition-sol-gel technique-characterization of nano materials-X-Ray diffraction- Scanning Probe Microscopy-atomic force microscopy-SEM and TEM techniques.**

#### **Course Outcome**

- (i) Discuss crystal physics, lattice vibrations, models of thermal properties and band theory of solids.**
- (ii) Explain the theoretical concepts of semiconductors, dielectric, magnetic and superconducting materials.**
- (iii) To describe the synthesis and characterization techniques of nanomaterials.**
- (iv) To apply the concepts in condensed matter physics to meet the challenges.**

#### **Books for study**

- 1. N.W. Ashcroft and N.D. Merwin, *Solid State Physics*, Cenage Learning India (2001)**
- 2. Charles. C. Kittel, *Introduction to Solid State Physics*, Wiley Student Edition (2007)**
- 3. M. Ali Omar, *Elementary Solid State Physics*, Pearson Education Inc (1999)**
- 4. K. K. Chattopahyay, A.N. Banerjee, *Introduction to Nano Science and NanoTechnology*, Prentice Hall of India (2009)**
- 5. Gabor L Hornyak, H F Tibbals and Joydeep Dutta, *Introduction to Nanoscience and Nanotechnology*, CRC press (2009)**

#### **References**

1. **S. O. Pillai, *Solid State Physics*, Third Edition New Age International Pvt. Ltd (1999).**
2. **M. A. Wahab, *Solid State Physics*, Narosa Publishing House (1999).**
3. **R. J. Singh, *Solid State Physics*, Dorling Kindersley (India) Pvt Ltd (2012).**
4. **P. Phillips, *Advanced Solid State Physics*, Second Edn., Cambridge University Press (2012).**

### **PHN 234 Nanostructured Materials (7L,1T)**

**Objectives:** This course is to introduce the student to the world of nanostructured materials. Different types of nanostructured materials, their general and specific characteristics will be discussed. Understanding the optical properties of metal nanoparticles and excitation processes in nanosystems is also intended. A broad understanding of different chemical and physical techniques employed for the synthesis of different types of nanomaterials and nanostructures is also envisaged through this course.

#### **Unit I (42 hours)**

**Characteristic scales in mesoscopic systems – nanoparticles - surface to volume ratio - grain boundary volume - surface energy - lattice contraction in nanostructured materials - semiconductor nanoparticles - Quantum confinement - artificial atoms - Quantum dots, Quantum wires, and Quantum wells - blue shift of band gap. Magic numbers - theoretical modelling of nanoparticles - geometric structure - electronic structure reactivity.**

**Optical properties of metal nanoparticle - surface plasmon resonance (SPR) – size, shape and composition dependence of SPR – dephasing of SPR – non-radiative decay of the SPR – plasmon wave guiding. Plasmonics-metallic nanoparticles and nanorods-metallic nanoshells-local field enhancement-plasmonic wave guiding-applications of metallic nanostructures. Nanocontrol of excitation dynamics-**

**nanostucture and excited states-rare earth doped nanostructures-up converting nanophores-quantum cutting.**

## **Unit II (42 hours)**

**Synthesis of nanomaterials– bottom-up and top-down approaches - metal nanoparticles - properties of individual nanoparticles - consequences of small particle size - increase of mechanical frequencies in small systems - dominance of viscous forces - disappearance of frictional forces.**

**Synthesis of zero-dimensional nanostructures - fundamentals of homogeneous nucleation - subsequent growth of nuclei - colloidal nanosynthesis - inorganic surface modification - shape control - phase transition and phase control - nanocrystal doping - synthesis of metallic (Au, Ag) nanoparticles - synthesis of semiconducting nanoparticles (CdSe, CdS ) - synthesis of oxide nanoparticles - sol-gel method - synthesis of multicomponent nanostructures - fundamentals of heterogeneous nucleation - synthesis of nanoparticles.**

**Epitaxial core-shell nanoparticles – core-shell quantum dots - type I and type II core-shell quantum dots - quantum dot quantum wells – Sonochemical synthesis of nanoparticles - spray pyrolysis – electrospinning.**

## **Unit III (42 hours)**

**Synthesis of 1D nanostructures - spontaneous growth - vapor-liquid-solid growth – template based synthesis - electrochemical deposition - electrophoretic deposition - template filling - synthesis of GaN nanostructures - synthesis of ZnO nanowires and heterostructures - GaP nanostructures.**

**Synthesis of 2D nano structures – fundamentals film growth – Physical vapour deposition – sputtering – chemical vapour deposition – atomic layer deposition – self assembly – Langmuir-Blodgett films.**



**Lithography techniques – optical lithography – electron beam lithography – focussed ion beam lithography – X-ray lithography.**

**Assignments: Applications of nanomaterials in various fields of science and technology including physics chemistry and biology and medicine.**

### **Course Outcome**

- (i) Distinguish between different classes of nanostructured materials and nanostructures based on dimension.**
- (ii) Understand the surface Plasmon resonance phenomena in metal nanoparticles as well as excitation processes involved in up conversion and down conversion.**
- (iii) Gain a broad understanding of the different chemical synthesis techniques of different types of nanostructured materials.**
- (iv) Gain broad understanding of advanced physical techniques employed for the preparation of 1D and 2D nanostructures including lithography.**

### **Books for Study**

- 1. Frank J. Owens, Charles P. Poole Jr, The Physics and Chemistry of Nanosolids, John Wiley & Sons, 2008.**
- 2. Dieter Vollath, Nanomaterials: An introduction to Synthesis, Properties, and Applications (second edition), Wiley-VCH, 2013.**
- 3. Charles P. Poole Jr, Frank J. Owens, Introduction to Nanotechnology, Wiley India Edition, 2006.**
- 4. Edward L. Wolf, Nanophysics and Nanotechnology - An Introduction to Modern Concepts in Nanoscience, Wiley-VCH, 2006.**
- 5. A.S. Edelstein, R.C. Cammaratra, Nanomaterials: Synthesis, Properties and Applications (second edition), CRC Press, 1998.**

6. V. I. Klimov (Ed.), Semiconductor and Metal Nanocrystals - Synthesis and Electronic and Optical properties, Marcel Dekker Inc., 2004
7. Kenneth J. Klabunde (Ed.), Nanoscale Materials In Chemistry, John Wiley & Sons, 2001
8. Guozhong Cao, Nanostructures and Nanomaterials- Synthesis, properties and Applications, Imperial college press, 2004.
9. Victor I. Klimov (Ed.), Semiconductor and Metal Nanocrystals- Synthesis and Electronic and Optical properties, Marcel Dekker, Inc., 2004.
10. Challa Kumar (Ed.). Semiconductor Nanomaterials, Wiley-VCH, 2010.
11. S. C. Tjong, Nanocrystalline Materials - Their Synthesis- Structure, Property Relationships and Applications, Elsevier, 2006.
12. Ampere A Tseng (Ed.), Nanofabrication-Fundamentals and Application, World Scientific, 2008.

#### **PH 241: NUCLEAR AND PARTICLE PHYSICS (6L, 1T)**

**Objectives:** To familiarize the fundamental properties of nucleus, its structure, models, nuclear reactions, nuclear detectors and accelerators. To introduce the concept of elementary particles and their interactions.

#### **Unit I**

##### **Nuclear forces (10 hours)**

Deuteron-neutron –proton scattering and proton-proton scattering at low energies-non central forces- nuclear exchange force-meson theory of nuclear forces

##### **Nuclear models (12 hours)**

Detailed studies on liquid drop, shell and collective models of the nuclei.

##### **Nuclear reactions (14 hours)**

Conservation laws-energetic nuclear reactions-Q value equation-partial wave analysis of nuclear reaction cross section- compound nuclear hypothesis-resonance reactions-Born-Wigner one level formula-optical model-theory of stripping reactions.

## **Unit II**

### **Nuclear fission (20 hours)**

Mechanism of nuclear fission-calculation of critical energy based on liquid drop model-fission products and energy release-fission chain reactions-neutron cycle and four factor formula-general features and classification of nuclear fission reactors.

### **Nuclear fusion (16 hours)**

Nuclear fusion in stellar interiors-proton-proton reactions-carbon-nitrogen cycle-thermo nuclear reactions in the laboratory-conditions for the construction of nuclear fusion reactor-critical ignition temperature-Lawson criterion-plasma confinement in fusion- principles of pinch, magnetic and inertial confinements.

## **Unit III**

### **Nuclear detectors and particle accelerators (20 hours)**

Gas filled detectors-ionization chamber and proportional counters-GM counter-scintillation detectors-semiconductor detectors- Cerenkov detector-bubble chamber. Particle accelerators- electrostatic accelerators-cyclotron accelerators-synchrotrons-linear accelerators-colliding beam accelerators.

### **Elementary particle physics (16 hours)**

Elementary particle interactions-symmetries and conservation laws-quark

model of elementary particles-colored quarks and gluons-ideas of charm, beauty and truth-quark dynamics-ideas of grand unified theories of fundamental forces

### **Course Outcome**

- (i) To describe and analyze nuclear structure, models and reactions.
- (ii) To illustrate the mechanisms of nuclear fission and fusion reactions.
- (iii) Discuss various nuclear detectors and particle accelerators.
- (iv) To classify elementary particles and discuss their interactions.

### **Books for study**

- 1 D. C. Tayal, *Nuclear Physics*, 5<sup>th</sup> Edition, Himalaya Publishing Co (2008)
- 2 J. Verma, R. C. Bhandari, D. R. S. Somayajulu Fundamentals of Nuclear Physics, CBS Publishers and Distributors (2005).
3. K. S. Krane, *Introductory Nuclear Physics*, Wiley India Pvt. Ltd (1988)

### **References**

1. S. B. Patel, *Nuclear Physics-An Introduction*, New Age International Pvt. Ltd (1996).
2. B. R. Marhu, *Nuclear and Particle Physics- an Introduction*, Second Edition, Wiley (2012)
3. S. N. Ghoshal, *Nuclear Physics*, S. Chand Ltd (1997)
4. M. P. Khanna, *Introduction to Particle Physics*, PHI (2011)
5. J. Freidberg, *Plasma Physics and Fusion Energy*, Cambridge University Press (2007)
6. F. F. Chen, *Introduction to Plasma Physics*, Springer, London (2002)

**Objectives:** This course will discuss the physical and chemical aspects of nanosolids starting from the dependence of electronic energy band structure on dimensionality. Understanding of the electrical and magnetic properties of nanomaterials that has both theoretical and practical importance is also envisaged. Nanophotonics, which is an emerging area of research that deals with light matter interaction at nanoscale is also discussed.

#### **UNIT I (30 hours)**

Low-dimensional systems - density of states in semiconductor materials - Quantum wells, Quantum wires, and Quantum dots - lithographic defined quantum dots - epitaxially self-assembled Quantum dots – colloidal quantum dots – weak confinement regime - strong confinement limit – Quantum-chemical calculations for semiconductor clusters –exciton –Dark exciton - Quantum dot lasers

Quantum wire devices - transport in one-dimensional electron systems (1 DES) - ideal 1 DES – semiconductor 1 DESs- silicon 1 DESs - semiconductor quantum dots as zero-dimensional electron systems (0 DES)

#### **Unit II (30 hours)**

Magnetism in nanostructures - characteristics of nanomagnetic materials - magnetic properties of single-domain particles – super-paramagnetism- coercivity of small particles - measurements of super-paramagnetism and blocking temperature - antiferromagnetic nanoparticles.

Electrical properties of semiconductor nanocrystals- theory of electron transfer between localized States - photoinduced charge transfer at nanoscale semiconductor interface - electrical conduction in bulk and nanostructured - charge transport in nanocrystal films.

Superconductivity in Nanomaterials- introduction - zero resistance – Meissner



**effect - dependence of superconducting properties on size effects - Resistivity and sheet resistance - proximity effect - superconductors as nanomaterials- tunneling and Josephson junctions - superconducting Quantum interference device (SQUID)**

### **Unit III (30 hours)**

**Nanophotonics- foundation for nanophotonics– free-space propagation - confinement of photons and electrons - propagation through a classically Forbidden zone - localization under a periodic potential - nanoscale optical interactions - near field-optics - theoretical modeling of near-field nanoscopic interactions - photonic crystals - basic concepts - theoretical modeling of photonic crystals - features of photonic crystals - methods of fabrication - photonic crystals and optical communication.**

**Assignment: Characterization techniques for nanostructures (i) XRD (ii) TEM (iii) AFM (iv) VSM**

### **Course Outcome**

- (i) Explain the electronic band structure and density of states of different types of nanostructures.**
- (ii) Understand how the magnetic properties of materials change due to nanometer crystallite sizes**
- (iii) Understand the effect of small size of the electrical response of semiconductors**
- (iv) Discuss superconductivity in nanomaterials**
- (v) Understand basic ideas about nanophotonics- phenomena and systems**

### **Books for Study**

- 1. Omar Manasresh, Introduction to Nanomaterials and Devices, John Wiley and Sons, 2012.**

2. **Gunter Schmid (Ed.), Nanoparticles- From Theory to Application, Wiley-VCH, 2004.**
3. **S. V Gaponenko, Optical Properties of Semiconductor Nanocrystals, Cambridge University Press, 1998.**
4. **Byung- Gook Park, Sung Woo Hwang, Young June Park, Nanoelectronic Devices, Pan Stanford Publishing, 2012,**
5. **Kenneth J. Klabunde, Nanoscale Materials in Chemistry, John Wiley and Sons, 2001.**
6. **Victor I. Klimov (Ed.), Semiconductor and Metal Nanocrystals- Synthesis and Electronic and Optical properties, Marcel Dekker, Inc., 2004.**
7. **Frank J Owens, Charles P. Poole Jr., The Physics and Chemistry Nanosolids, John Wiley and Sons, 2008.**
8. **Paras N Prasad, Nanophotonics, Wiley-Interscience, 2004.**
9. **S. Zhang, Lin Li, A. Kumar, Materials Characterisation Techniques, CRC Press, 2008.**
10. **Y. Leng, Materials Characterisation: Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia), 2008.**
11. **D. A. Skoog, F.J. Holler, S. R. Crouch, Instrumental Analysis, Cengage Learning, 2007.**
12. **W. W. Wendlandt, Thermal Methods of Analysis, John Wiley, 1974.**
13. **D. B. Williams and C. B. Carter, Transmission Electron Microscopy, Vol. I-III. Springer, 1996**

#### **PHN 243: NANO ELECTRONICS (5L,1T)**

**Objectives:** This course will provide basic and advanced concepts on nanoelectronics. Understanding quantum electronic devices including single electron transistor is also intended. Basic ideas of the use of carbon nanostructures in electronic devices is also included. A detailed discussion of the spintronic devices of practical importance is also included.

## **UNIT I (30 hours)**

**Nanoscale electronics – Moor's law - limits of micro miniaturization in Silicon – scaling - milestones of Silicon Technology - estimation of Technology limits - introduction to nanoscale electronics - three-dimensional nanostructures - two-dimensional nanostructures - one-dimensional nanostructures - MOSFET scaling trend.**

**Quantum electronic devices – short-channel MOS transistor - electronic devices based on nanostructures – MODFETs -heterojunction bipolar transistors – Resonant tunnel effect- tunneling diode - resonant tunneling diode - hot electron transistors - resonant tunneling transistor.**

## **Unit II (30 hours)**

**Single electron tunneling - Coulomb blockade - single electron transistor (SET) - performance of SET - fabrication of SET - operation of single electron transistors -mesoscopic arrays with nano electrodes - from single particle properties to collective charge transport – one, two, and three-dimensional arrangement of particles - logic circuits with single electron transistors - bias conditions for SETs – design scheme for SET logic circuits.**

**Carbon nanostructures – fullerene - graphene - carbon nanotubes (CNTs) - synthesis of carbon nanotubes - functionalization - doped carbon nanotubes - geometrical structure - electronic structure of graphene - electronic structure of CNT - metallic and semiconducting CNTs - electron transport in CNTs - operation and performance of CNFETs – CNT circuits - scaling of CNFETs to the sub - 10nm regime - prospects of an all -CNT nanoelectronics.**

## **Unit III (30 hours)**

**Spintronics – spin-tight diffusion length – spin dependent resistivity in transition metal alloys- giant magnetoresistance (GMR) – Mott’s two-current model - experiments on GMR- GMR spin value - spin injection - spin injection into a non-magnetic conductor - spin injection in semiconductors - magnetic Random Access Memory (MRAM) – Silicon-based spin transistor - design and fabrication - electrical characterization – spin-FETs - spin-MOSFETs.**

#### **Course outcome**

- (i) Understand the idea of miniaturization of electronic devices**
- (ii) Understand the basic phenomena and devices in nanoelectronics.**
- (iii) Understand the working of a single electron transistor and circuits involving it**
- (iv) Familiarize nanoelectronic devices employing carbon nanostructures**
- (v) Understand spintronic devices and phenomena involved such as giant magnetoresistance.**

#### **REFERENCES**

- 1. K. Goser, P. Glosekotter, J. Dienstuhl, Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer, 2004.**
- 2. Seng Ghee Tan, Mansoor B. A. Jalil, Introduction to the Physics of Nanoelectronics, Woodhead Publishing Limited, 2012.**
- 3. Byung- Gook Park, Sung Woo Hwang, Young June Park, Nanoelectronic Devices, Pan Stanford Publishing, 2012.**
- 4. J. M. Martinez- Duarte, R.J Martina- Palma, F. Agullo-Rueda, Nanotechnology for Microelectronics and Optoelectronics, Elsevier, 2006.**
- 5. Gunter Schmid (Ed.), Nanoparticles - From Theory to Application, Wiley-VCH, 2004.**

6. Rainer Waser (Ed.), Nanoelectronics and Information Technology-Advanced Electronic Materials and Novel Devices (2ndCorrected Ed.), Wiley-VCH, 2005.
7. Francois Leonard, The Physics of Carbon Nanotube Devices, Elsevier, First Indian Print, 2013.
8. An Chen, James Hutchby, Victor Zhimov, George Bourianoff (Eds.), Emerging Nanoelectronic Devices, Wiley, 2015.
9. Teruya Shinjo, Nanomagnetism and Spintronics, Elsevier, 2009.
10. Thomas Heinzl, Mesoscopic Electronics in Solid State Nanostructures, 2nd Ed., Wiley-VCH, 2007
11. Y. BXu and S. M Thompson (Eds), Spintronic Materials and Technology, Taylor & Francis, 2007.

#### **PH 251: GENERAL PHYSICS PRACTICALS**

**Objectives:** Demonstrate and understand various general physics experiments for acquiring fundamental concepts.

**(Total of 12 experiments to be done from Section A and B)**

#### **Section A (at least 6 experiments to be done in this section)**

1. Determination of elastic constants by Cornu's method (elliptical and hyperbolic fringes)
2. Analysis of absorption spectra of liquids using spectrometer
3. Determination of  $e/k$  using Ge and Si transistors
4. Anderson Bridge –determination of self and mutual inductance
5. Michelson Interferometer experiments
6. Identification of Fraunhofer lines in solar spectra
7. Verification of Richardson's equation using diode valve
8. Thermal diffusivity of brass
9.  $e/m$  of an electron-Thompson's method
10. Charge of an electron-Millikan's method



11. **Determination of Fermi energy of Copper**
12. **Study of variation of resistance of a semiconductor with temperature and determination of band gap**
13. **Magnetic Susceptibility of a liquid using Quincke's method**
14. **Ferromagnetic studies using Guoy's method**
15. **Hall effect in a semiconductor**
16. **Thermo-emf of bulk samples like Al, Cu. Brass etc.**
17. **Zeeman effect using Fabry-Perot Interferometer.**

**Section B (*at least 6 experiments to be done from this section*)**

1. **BH curve-anchor ring**
2. **Study of photoelectric effect and determination of Planck's constant**
3. **Determination of Stefan's constant**
4. **Experiments using Laser:**
  - (a) **Laser beam characteristics**
  - (b) **Diffraction grating**
  - (c) **Diffraction at different types of slits and apertures**
  - (d) **Refractive index of liquids**
  - (e) **particle size determination**
5. **Young's modulus of different materials using strain gauge**
6. **Determination of magnetic force in a current carrying conductor**
7. **Optical fibre characteristics-numerical aperture, attenuation and bandwidth of given specimen.**
8. **Cauchy's constants of liquids and liquid mixtures using hollow prism and spectrometer**
9. **Surface tension of a liquid using Jaeger's method.**
10. **Analysis of powder XRD data.**
11. **Study of stellar spectral classification from low dispersion stellar spectra**
12. **Study of HR diagram of stars**
13. **Radioactive material counting statistics**
14. **Interpretation of UV- visible spectra of materials**
15. **Electrical characteristics of a solar cell**

## **Course Outcome**

- (i) To measure and analyze various physical quantities.
- (ii) To calculate error in various general physics experiments.
- (iii) To develop experimental skills

## **PH 252 Electronics and Computer Science Practical**

**Objectives:** Design, construct and verify various electronics circuits and object oriented programing using C++ to solve numerical problems.

### **Unit I – Electronics Experiments (A total of 12 experiments to be done)**

#### **Section A (*at least 6 experiments to be done*)**

1. Single stage CE amplifier –Design and study of frequency response
2. Study of RC Phase shift oscillator circuits using Transistors
3. Construction and study of a stable multivibrator and VCO circuits using Transistors
4. Study of OP Amp circuits (a) summing amplifier (b) difference amplifier
5. OP Amp as an integrator and differentiator
6. Characteristics of JFET and MOSFET
7. Characteristics of SCR
8. Design and study of negative feedback amplifier circuits
9. Study of Clipping and Clamping circuits
10. UJT Characteristics and UJT relaxation Oscillator
11. Study of active filters using OP amps (a) low pass (b) high pass (c) band pass for both first order and second order-gain/ roll off determination
12. Wave form generation using OP amp circuits: (a) astable and monostable multivibrators (b) square, triangular and saw-tooth wave generation
13. IC 555 timer experiments (a) monostable and astable multivibrators (b) VCO
14. D/A convertor circuits using OP Amp 741

15. **Differential amplifier circuits using transistors**
16. **Design of series pass voltage regulators using transistors with load and line regulation (b) Op Amp**

**Section B** (*at least 6 experiments to be done*)

1. **Emitter follower and source follower circuits**
2. **Weinberg oscillator using OP Amp**
3. **SR and JK Flip Flops -construction using Logic Gates and study of truth tables**
4. **Study of the frequency response of a tuned amplifier**
5. **Study of power amplifier circuits**
6. **Frequency multiplier using PLL**
7. **Study of Schmitt trigger circuits using transistors**
8. **Construction and study of cascade amplifier circuit using transistors.**
9. **Digital modulation circuits (a) BFSK generation using 555 timer (b) BFSK detector using 555 timer and PLL (c) BPSK generation**
10. **Shift register and ring counter circuits using flip flops**
11. **Miscellaneous transistor applications (a) automatic night light with LDR**
12. **inverter circuit (transistors as a switch) (c) time delay circuit using SCR**
13. **BCD to decimal decoder and seven segment display using IC**
14. **Design of Electronic counters (up and down counters)**

**Unit II Computer Programming**

*(A minimum of 8 experiments to be done, programs should be written in C++ language)*

1. **Least square fitting**
2. **First derivative of tabulated function by difference table**
3. **Numerical integration (Trapezoidal rule and Simpson method)**
4. **Solution of algebraic and transcendental equations using Newton-Ralphson method**
5. **Solution of algebraic equations using bisection method**
6. **Numerical interpolation using Newton and Lagrangian methods**

7. Monte Carlo simulation
8. Evaluation of Bessel and Legendre functions
9. Matrix addition, multiplication, trace, transpose and inverse.
10. Fourier series analysis
11. Study of motion of projectile in a central force field
12. Study of Planetary motion and Kepler's laws

#### **Course Outcome**

- (i) To design and construct various electronic circuits and its validation.
- (ii) To calculate error in various electronics experiments.
- (iii) To develop experimental and programming skills

#### **PHN 244: Lab. NANOSCIENCE**

**Objectives:** This course will provide basic ideas about the phenomena, physical parameters and characterization techniques relevant to the study of nanostructures materials.

#### **List of experiments - minimum 10 experiments to be done**

1. Analysis of given X-ray diffraction pattern of nanocrystalline samples with different crystallite sizes – crystallite size and microstrain.
2. X-ray diffraction-structure evaluation and identification of material.
3. Interpretation of electron diffraction patterns (SAED pattern) of nanocrystalline samples with different sizes.
4. Determination of particle size of given material using He-Ne laser or diode laser
5. Determination of Fermi energy of copper
6. Study of variation of resistance of a semiconductor with temperature
7. Hall effect in a semiconductor

8. Measurement of resistivity of low and high resistivity semiconductors-four probe method
9. Photo current measurement in a semiconductor
10. Measurement of magnetoresistance of semiconductors
11. Determination of thickness of a film by envelope method and calculation of band using the given transmittance spectrum of the film.
12. Determination of band gap of a semiconductor nanomaterial using UV-visible absorption spectra
13. Preparation of a thin film nanostructured sample using vacuum deposition technique
14. Preparation of a multilayered nanostructured thin film using vacuum deposition technique
15. Synthesis of metal nanoparticles using Turkevich procedure.
16. Synthesis of metal nanoparticle synthesis using Biphasic reduction.
17. Synthesis of CdSe quantum dots and its characteristics.
18. Measurement of absorbance of Au nanoparticles
19. Calculate the concentration of Au nanoparticles using Beer' Law.
20. Demonstrate the working of the self-assembly of nanoparticles on a solid support.
21. Construct a simple nanostructured photovoltaic cell and study its basic characteristics.
22. Distinguish the characteristics of any three dyes and comment on your observations.
23. Any other experiment with equal standards can be included.

#### **Course Outcome**

- (i) Measure crystallite size and micro-strain from XRD analysis
- (ii) Interpret the results of experiments commonly employed for characterization of nanomaterials.
- (iii) DO and interpret results of various characterization techniques commonly required for understand physics at nanoscale.



**(iv) Do some basic preparation/synthesis techniques on nanomaterials  
/nanostructures**