**D 132066** **(Pages : 2)** **Name.....**

**Reg. No.....**

**THIRD SEMESTER M.Sc. DEGREE [REGULAR/SUPPLEMENTARY] EXAMINATION, NOVEMBER 2025**

(CBCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

**Section A**

*Answer* **all** *questions, each carries weightage* 1.

1. Discuss the functions of the oil in a rotary vacuum pump.
2. Explain why thin targets are preferred in any nuclear technique for elemental analysis.
3. What are the major applications of the pirani gauge ?
4. What is the principle of thin film preparation by the sputtering technique ?
5. Illustrate the amorphous and channeling peaks in ion implantation technique.
6. What are the disadvantages of resistive heating technique for thin film preparation ?
7. Explain the principle of a cyclic accelerator.
8. What are the advantages of ion implantation technique ?

(8 × 1 = 8 weightage)

**Section B**

*Answer any* **two** *questions, each carries weightage* 5.

9. State and Explain Bragg's law of diffraction ? Explain the instrumentation for powder X-ray diffraction technique ?
10. How does the Cryogenic pumps work ? Explain with the help of neat diagram.

**Turn over**

11. Explain the principle of linear accelerators. With the help of neat diagram explain the working of Van de Graaff accelerator.

12. Describe the glow discharge technique for thin film preparation. How do you measure thin film thickness by electric resistivity measurement ?

(2 × 5 = 10 weightage)

## Section C

*Answer any* **four** *questions, each carries weightage* 3.

13. Explain the method of thickness measurement using quartz crystal monitor.

14. Describe the sorption pump using a neat diagram. What are the advantages and disadvantages ?

15. If the potential difference across an X-ray tube is 6000 Volt and the current through it is 2.5 mA, calculate the number of electrons striking the target per second and the speed at which they strike. Also calculate the shortest wavelength of X-rays produced.

16. A fifteen stage turbo molecular pump with a blade tip velocity of 500 m/s has a compression ratio at 25 °C for $N_2$ of $7.7 \times 10^8$. What is the compression ratio of the pump when it is pumping hydrogen ?

17. Describe the method for element determination by neutron activation analysis.

18. An alpha particle with a momentum 53 MeV/c is scattered at an angle 60° by the Coulomb field of a stationary uranium nucleus (A = 238). Find the impact parameter.

19. Using the principles of energy and momentum, deduce an expression relevant to the qualitative analysis of the sample for X in a nuclear reaction, X ($a$, $b$) Y. The $q$-value is taken 'Q' and the outgoing particle $b$, makes 0 angle with the incident beam direction.

(4 × 3 = 12 weightage)

**D 111214** **(Pages : 2)** **Name.....**

**Reg. No.....**

**THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2024**

(CBCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

**Section A**

*Answer* **all** *questions.*
*Each question carries weightage* 1.

1. Explain what is meant by oil suck back in a rotary pump.
2. Explain why thin targets are preferred in any nuclear technique for elemental analysis.
3. Draw the diagram of Pirani gauge and labelits parts.
4. What is the principle of thin film preparation by the sputtering technique ?
5. Illustrate the amorphous and channeling peaks in ion implantation technique.
6. Explain laser evaporation technique in thin film deposition.
7. Explain the principle of a cyclic accelerator.
8. Write a short note on PIXE.

(8 × 1 = 8 weightage)

**Section B**

*Answer any* **two** *questions.*
*Each question carries weightage* 5.

9. Describe the powder method for X-ray diffraction. Discuss the formation of diffraction pattern on the photographic film
10. How does the Cryogenic pumps work. Explain with the help of neat diagram.

**Turn over**

11. Explain the principle of linear accelerators. With the help of neat diagram explain the working of Van de Graaff accelerator.

12. Discuss what are multi-layer optical filters. Describe their structure and applications.

(2 × 5 = 10 weightage)

## Section C

*Answer any* **four** *questions.*
*Each question carries weightage* 3.

13. Describe the four probe method to find the thickness of thin films. Obtain the expression for thickness in terms of resistivity.

14. Describe the sorption pump using a neat diagram. What are the advantages and disadvantages ?

15. The utilized reflecting plane of a lithium fluoride crystal has an inter-planar distance of 2.5 A°. Calculate the wavelength of the $2^{nd}$ order line which has a glancing angle of 60°.

16. A fifteen stage turbo molecular pump with a blade tip velocity of 500 m/s has a compression ratio at 25 °C for $N_2$ of $7.7 \times 10^8$. What is the compression ratio of the pump when it is pumping hydrogen ?

17. Describe the method for element determination by neutron activation analysis.

18. A beam of 10 MeV neutrons is incident on a $^{19}F$ target producing the nuclear reaction $^{19}F$ (n, p) $^{19}O$. If the Q-value of the reaction is – 3.7 MeV, find the energy of the protons that are emitted at 90° to the direction of the incident *n*-beam.

19. Using the principles of energy and momentum, deduce an expression relevant to the qualitative analysis of the sample for X in a nuclear reaction, X (*a*, *b*) Y. The *q*-value is taken 'Q' and the outgoing particle *b*, makes 0 angle with the incident beam direction.

(4 × 3 = 12 weightage)

**D 51336** **(Pages : 2)** **Name.....**

**Reg. No.....**

**THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2023**

(CBCSS)

Physics

PHY3E 05—EXPERIMENTAL TECHNIQUES

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

**Section A**

*Answer* **all** *questions, each carries weightage* 1.

1. Explain what is meant by oil suck back in a rotary pump.
2. What are the limitations of RBS technique ?
3. Define thermoelectric power. How is it useful.
4. Explain the principle used in a Tandem Van de Graaff accelerator.
5. Draw the diagram of Pirani gauge and label its parts.
6. Explain laser evaporation technique in thin film deposition.
7. What are the main applications of accelerators ?
8. Write a short note on PIXE.

(8 × 1 = 8 weightage)

**Section B**

*Answer any* **two** *questions, each carries weightage* 5.

9. Describe the powder method for X-ray diffraction. Discuss the formation of diffraction pattern on the photographic film.
10. Draw a neat diagram of an oil sealed rotary vacuum pump. Explain the principle and working. Explain the function of the oil.

**Turn over**

11. Explain in detail : (a) The principle behind the PIXE technique ; (b) Discuss the instrumentation ; and (c) The merits and limitations of this technique.

12. Discuss what are multi-layer optical filters. Describe their structure and applications.

(2 × 5 = 10 weightage)

## Section C

*Answer any* **four** *questions, each carries weightage* 3.

13. Describe the four probe method to find the thickness of thin films. Obtain the expression for thickness in terms of resistivity.

14. Discuss the principle and working of Cold Cathode Ionization Gauge.

15. The utilized reflecting plane of a lithium fluoride crystal has an inter-planar distance of 2.5 A°. Calculate the wavelength of the $2^{nd}$ order line which has a glancing angle of 60°.

16. A synchro-cyclotron meant for accelerating deuterons (mass = 2.01478 amu) has a magnetic flux density of 1.43 T and 1.5 T at the orbit and at the centre respectively. Calculate the maximum frequency of the dee voltage and the energy gained by the deuterons. Assume that the dee-voltage frequency is modulated between this maximum and a minimum of 10 MHz.

17. A beam of 10 MeV neutrons is incident on a $^{19}F$ target producing the nuclear reaction $^{19}F$ $(n, p)$ $^{19}O$. If the Q-value of the reaction is – 3.7 MeV, find the energy of the protons that are emitted at 90° to the direction of the incident $n$-beam.

18. Derive expression connecting impact parameter and angle of scattering in Rutherford scattering process.

19. A proton accelerator consists of 200 drift tubes. The rf electric field has a frequency of 500 MHz. The average potential when the protons cross the accelerating gap is $1.5 \times 10^3$ kV. If the protons are injected into the machine at 2 MeV energy, calculate the final energy and the length of the last drift tube.

(4 × 3 = 12 weightage)

**D 31205** **(Pages : 3)** **Name.....**

**Reg. No.....**

**THIRD SEMESTER M.Sc. DEGREE [REGULAR/SUPPLEMENTARY] EXAMINATION, NOVEMBER 2022**

(CBCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

**Section A**

*Answer* **all** *questions.*
*Each question carries weightage* 1.

1. Explain what happens in rotary oil pump if it stops working under vacuum conditions. Suggest a method to solve this problem.
2. Define with units throughput Q and pumping speed S of a vacuum pump. Plot the variation of S with pressure for a rotary.
3. Give *two* advantages of the spottering technique for thin film fabrication over the vacuum evaporation techniques.
4. What special technique is used in a tandem Van de Graaff accelerator to increase the available ion energy over that from a normal Van de Graaff accelerator ?
5. Explain two disadvantages of a Cyclotron.
6. Explain the origin of the background in the $P_1 \times E$ spectrum of a realistic sample.
7. Briefly describe the method for determination of depth profile of impurity concentration in a sample.
8. Explain the difference between single crystal and powder diffraction using X-rays.

(8 × 1 = 8 weightage)

**Turn over**

## Section B

*Answer any* **two** *questions.*
*Each question carries weightage* 5.

9. (a) Explain, using a diagram, the principle and working of a rotary oil pump.

   (b) What is a gas ballast and its use ?

10. (a) Explain why vacuum is required for thin films by the thermal evaporation technique ?

    (b) Describe the set up and its working for the above technique for thin film fabrication. Give a neat diagram for explanation.

11. (a) Explain the theory, construction and working of a modern synchrotron providing necessary sketch.

    (b) Mention two of its important applications.

12. (a) Illustrate the principle of the RBS technique for elemental analysis.

    (b) With reference to a diagram of the experimental set up for the above technique, explain how the same is used for a practical application.

(2 × 5 = 10 weightage)

## Section C

*Answer any* **four** *questions.*
*Each question carries weightage* 3.

13. Calculate the pumping speed of a rotary oil pump to produce a vacuum level of $2 \times 10^{-3}$ Torr in 25 minutes inside a cubical pressure chamber of side 20 cm, starting from atmospheric pressure.

14. In the measurement of the thin film thickness by the optical interference method, the $n^{th}$ order maximum for a light of wavelength $\lambda$, is observed to coincide with the $(n + 1)^{st}$ order maximum for a nearby wavelength $\lambda_2$, at normal incidence. Deduce the expression for the thickness $t$ in terms of the refractive index $\mu$ of the film and the wave lengths.

15. It is required to obtain $^{32}_{16}S$ ions with an energy of 4 MeV per nucleon using a tandem Van de Graaff accelerator. The charge state of the ions selected is 10+. what should be the terminal potential ? What will be the velocity of the ions ? (1 amu = 931.4 MeV).

16. The $^{7}Li(p,\alpha)$ reaction is being used to estimate the lithium content in a sample. What is the residual nucleus ? Is there a threshold energy for this reaction ? What is the value in the laboratory ? The detector for the emitted particles is kept at 45° to the incident proton beam energy whose is 5 MeV above the threshold. Obtain the energy of the alphas detected. (Given the nuclide masses : $^{7}Li$ : 7.01601, $^{1}H$ = 1.007825, and $^{4}He$ : 4.002603, all in amu).

17. Polonium (Mass number = 209) is the only element known to crystallize in simple cubic structure. Its density is 9.196 g/cm$^3$. Calculate the lattice constant a. Cu k$\alpha$ radiation of energy 8.04 Kev is used to study the crystal structure using X-ray diffraction. Obtain the angle at which first order reflection occurs from the set of planes parallel to one of its faces.

18. Deuterons are accelerated in a cyclotron. Determine the frequency of the accelerating voltage source given the strength of the magnetic field = 1.5 T and the mass of the particles = $3.3 \times 10^{-27}$ kg. If the ions come out of the cyclotron with a kinetic energy of 16 MeV, calculate the cyclotron radius at which they leave the machine.

19. Considering each phase of the entire process for materials analysis by Neutron Activation technique, give a step by step derivation of the expression for the number of gamma rays detected by a HPGe detector per second in terms of the mass $m$ of the particulars isotope in the sample, the beam current I and other relevant parameters of the experimental set up.

(4 × 3 = 12 weightage)

**D 11696** **(Pages : 3)** **Name.....**

**Reg. No.....**

**THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, NOVEMBER 2021**

(CBCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

**General Instructions**

1. *In cases where choices are provided, students can attend* **all** *questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

**Section A**

*Answer* **all** *questions.*
*Each question carries weightage* 1.

1. What are the basic functions of the working fluid in an oil rotary pump ?
2. Give an idea about the fundamental principle of the working of getter ion pump.
3. Explain the function of the quartz crystal in a thickness monitor for thin films.
4. What is the mechanism of the sputter ion deposition technique for thin film fabrication ?
5. Explain why the successive accelerating tubes in a linear accelerator have progressively increasing lengths.
6. What are the special advantages of ion implantation technique ?
7. Back angles are preferred in the RBS technique for materials analysis. Why ?
8. What is a unit cell ? What is its shape and parameters ?

(8 × 1 = 8 weightage)

**Turn over**

## Section B

*Answer any* **two** *questions.*
*Each question carries weightage* 5.

9. (a) With the help of a neat diagram discuss the working principle and working of a turbo molecular pump.

   (b) Explain the concept of pumping speed.

10. (a) Describe the glow discharge technique for thin film fabrication.

    (b) Write a note on multi layer optical filters and their uses.

11. (a) What is PIXE ? Explain the general set up for trace element analysis via this technique, providing a neat sketch of the same.

    (b) Discuss the application of the PIXE techniques for human hair samples.

12. (a) State and explain Bragg's law of X-ray diffraction.

    (b) Describe the instrumentation for single crystal diffraction studies.

(2 × 5 = 10 weightage)

## Section C

*Answer any* **four** *questions.*
*Each question carries weightage* 3.

13. A vacuum chamber in the form of a sphere with radius of 25 cm is pumped by a diffusion pump, starting from an inlet pressure $1 \times 10^{-3}$ Torr to an ultimate pressure of $8 \times 10^{-7}$ Torr. If the effective pumping speed of 150 litres/sec, calculate the pump down time.

14. A vacuum evaporation unit is used to coat a thin aluminium film on a substrate kept a distance of 15 cm from the heating boat 1 gram of the metal is taken in the boat and is evaporated completely. Find the thickness of the thin film obtained, in microns ($\rho$ = 2.7 g/cm$^3$). The film thickness is measured in an interferometer using light of wavelength 589 nm. Obtain the fringe shift given $\mu$ = 1.5.

15. The r.f. field in a cyclotron used for accelerating alpha particles is 15 MHz. The Dees have a radius of 0.6 m. Obtain the strength of the magnetic field and the maximum energy attained by the ions.

16. The thermal column of a nuclear reactor provides a neutron flux of $10^{12}$ n/cm$^2$/sec. A sample containing $^{10}$B is subjected to NAA using the $(n, r)$ reaction in this column. What is the radio active isotope produced ? The radio activity produced has a half life of 30 minutes. Gamma counting is started 15 minutes after irradiation is over. 1,000 gammas are detected for 2 minutes by means of a HPGe detector of efficiency 2%, kept subtending a solid angle of $2 \times 10^{-3}$ sr at the sample centre. Calculate the mass of the isotope in the sample, assuming $\sigma$ = 100 mb.

17. An experiment is carried out to determine the particle size of a powder sample using X-ray diffraction. The FWHM of the diffraction peak at 31.8° is obtained as 0.5 degrees, when Cu kα radiation of energy 8.04 keV is used. Calculate the particle size.

18. A linear accelerator operating at r.f. frequency of *f* kHz and *rf* field amplitude of V k Volts is used to accelerate ions of charge *ne* and mass *m* with an initial energy of E0 keV. Derive expressions for the length of the $n^{th}$ drift tube and the exit energy of the ions after *n* drift tubes.

19. The reaction X (a, b) Y with a *q*-value Q is used for analysis of a sample containing the isotope X by detecting the outgoing particles *b* at an angle 0 to the incident beam direction. Using the principles of conservation of energy and momentum, deduce an expression relevant to the qualitative analysis of the sample for X.

(4 × 3 = 12 weightage)

**D 91058** (Pages : 3) Name.....

Reg. No.....

# THIRD SEMESTER M.A./M.Sc./M.Com. DEGREE [REGULAR] EXAMINATION, NOVEMBER 2020

(CBCSS)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2019 Syllabus year)

Time : Three Hours Maximum : 30 Weightage

## General Instructions

1. *In cases where choices are provided, students can attend* **all** *questions in each Section / Part.*
2. *The minimum number of questions to be attended from the Section / Part shall remain same.*
3. *There will be an overall ceiling for each Section / Part that is equivalent to maximum weightage of the Section / Part.*

## Section A

*Answer* **all** *questions.*
*Each carries weightage* 1.

1. What is a liquid nitrogen trap ? How does it work ?
2. Explain the phenomenon of oil back streaming in a diffusion pump. How can this be prevented ?
3. Give the basic principle of the technique of using ion sputtering process for thin film fabrication.
4. Briefly describe thermo electric power and its measurement.
5. How high voltages are developed on the terminal of a Van de Graaff accelerator without sparking ?
6. Explain the basis for using the Nuclear Reaction Analysis technique for materials analysis.
7. Explain the high sensitivity and multi-elemental nature of the PIXE method of trace element analysis.
8. State and explain the Scherrer equation in X-ray diffraction.

(8 × 1 = 8 weightage)

## Section B

*Answer any* **two** *questions.*
*Each carries weightage* 5.

9. (a) What is the role of the cryo surface in a vaccum pump ?

   (b) Describe in detail with the help of a neat diagram, the structure and working of a cryo pump.

**Turn over**

10. (a) Explain using a neat diagram the principle and details of the optical interferometer method of thickness measurement of thin films.

    (b) Write a note on electrical conductivity measurement of thin films.

11. (a) What is the basic principle behind the operation of a Cyclotron, with supporting diagram.

    (b) Give the details of the components of the accelerator and its working.

12. (a) Outline the basic theory of materials analysis by the NAA technique.

    (b) Describe the instrumentation and procedure for the above, giving the necessary diagram.

(2 × 5 = 10 weightage)

## Section C

*Answer any* **four** *questions.*
*Each carries weightage* 3.

13. For a vacuum pump with an effective pumping speed of 1000 litres/s at a pressure of $10^{-3}$ Torr, calculate the throughput. Also, draw the variation of the pumping speed *vs.* pressure for a rotary pump.

14. A quartz crystal monitor having an initial thickness of 0.2 mm and density 2.3 g/cm$^3$ is used in a thin film fabrication unit. For a given aluminium thin film deposit the reduction in crystal frequency is found to be 2 kHz. Calculate the initial crystal frequency and the thickness. Given ρ for aluminium = 2.7 g/cm$^3$ and the crystal frequency constant N = 1.537 × $10^5$Hz – cm.

15. A proton linear accelerator has 40 drift tubes of gradually increasing lengths. The r.f. voltage amplitude used is 400 kV and frequency is set to 200 MHz. Calculate the length of the 25$^{th}$ drift tube and the exit energy of the protons, given that the ion source injects 80 keV protons into the first drift tube.

16. A sample containing traces of silicon impurity is to be analyzed using the RBS technique with 8 Mev alpha particles. The silicon detector is kept at an angle of 150°. Calculate the energies of the two scattered alpha peaks corresponding to the two isotopes of Si with masses 28 and 30. What should be the minimum resolution of the detector in order that these two peaks are just resolved ?

17. Potassium with atomic mass 39 has a b.c.c. structure with a lattice parameter $a$ = 0.52 nm. Estimate its density based on the crystal structure. When μo $k\alpha$ radiation (17.926 keV) is used for X-ray diffraction measurement of the K crystal sample, obtain the angle at which a strong peak corresponding to reflections from the [111] planes will be observed.

18. Derive an expression for the energy of ions of mass M and charge state $q$ after the stripper foil, accelerated through a tandem van de Graaff accelerator of terminal potential V Mega volts. Thus , obtain the energy and velocity of $5^{+}$ $^{32}S$ ions delivered by the accelerator of V = 12. Calculate also the number of such ions delivered per second if the beam current is 20 namps.

19. Considering each phase of the entire procedure for trace analysis by the PIXE technique using a proton accelerator, give a step by step derivation of the expression for the number of X-rays detected by the Si (Li) detector per second in terms of the mass $m$ of the particular element investigated and the beam current I and other relevant parameters.

(4 × 3 = 12 weightage)

**D 70990** PG (Pages : 2) Name.....

Reg. No.....

# THIRD SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION
## NOVEMBER 2019

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2017 Admissions)

Time : Three Hours Maximum : 36 Weightage

### Section A

*Answer* **all** *questions.*
*Each question carries a weightage of* 1.

1. Explain briefly the principle of operation of turbo molecular pump.
2. What are O rings and gaskets ? Give their uses.
3. What is back streaming in a diffusion pump ? How is it prevented in practice ?
4. Distinguish between thermal evaporation and sputtering techniques for thin film deposition.
5. What are multilayered films ? Explain their applications.
6. Explain the principle of linear electrostatic accelerator.
7. Explain what is ion plasma source.
8. Explain what is meant by kinematic factor? Obtain an expression for the same.
9. What is ion channeling ? How can one avoid the channeling peak in ion implantation ?
10. Explain why radiochemical separation becomes necessary very often in NAA measurements.
11. Derive Bragg's law of diffraction.
12. What are the applications of X-ray diffraction analysis ?

(12 × 1 = 12 weightage)

### Section B

*Answer any* **two** *questions.*
*Each question carries a weightage of* 6.

13. Draw a neat diagram of oil sealed rotary vacuum pump. Explain the principle and working and the function of oil.

**Turn over**

14. Explain the principle of thermal evaporation technique for thin film deposition. What are the different methods employed in this technique? With a neat sketch explain in detail any one of the methods.

15. Explain the tandem principle for accelerating charged particles. With the help of a diagram, explain the principle and working of a Tandem Van de Graaff accelerator.

16. Explain the principle of the PIXE technique for elemental analysis. Draw and explain the experimental setup for the same.

(2 × 6 = 12 weightage)

## Section C

*Answer any* **four** *questions.*
*Each question carries a weightage of* 3.

17. What should be the speed of UHV pump to be used to achieve a vacuum of $10^{-10}$ Torr, if the outgassing load on the chamber is $10^{-9}$ Torr litres $s^{-1}$ ?

18. A quartz crystal monitor indicates a change in frequency of 1600Hz when an aluminium film of density 2.7gcm$^{-3}$ is deposited on its face. Determine the film thickness. If the quartz crystal is 0.2mm thick and the density of quartz is 2.7gcm$^{-3}$, estimate the starting frequency of the crystal.

19. In a cyclotron driven at a frequency of 10MHz, alpha particles are accelerated up to a maximum radius of curvature of 50cm. The effective voltage applied to the dees is 50kV. Neglecting the gap between dees, calculate the total acceleration time of the particle and the total distance covered by the particles during the complete cycle of acceleration.

20. An alpha particle with a momentum 53MeV/c is scattered at an angle 60° by the Coulomb field of stationary uranium nucleus (A = 238). Find the impact parameter.

21. A beam of X-rays of wavelength 0.071 nm is diffracted by (110) plane of rock salt with lattice constant of 0.28 nm. Find the glancing angle for the second-order diffraction.

22. Give a brief account of diffractometer instrumentation.

(4 × 3 = 12 weightage)

D 52347 (Pages : 2) Name.....

Reg. No.....

# THIRD SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2018

(CUCSS—PG)

Physics

PHY 3E 05—EXPERIMENTAL TECHNIQUES

(2017 Syllabus Year)

Time : Three Hours Maximum : 36 Weightage

## Section A

*Answer* **all** *questions.*

*Each question carries a weightage of* 1.

1. Explain what is meant by oil suck back in a rotary pump.
2. What is a sorbent material ? Give examples.
3. Explain Knudsen cosine law.
4. Explain why vacuum is required for thin film preparation by thermal evaporation technique ?
5. Give a brief account of thin film thickness measurement by optical interference method.
6. Explain the important principle used in Van de Graaff accelerator.
7. What are the factors that enforce an upper limit to the ion energies available from cyclotrons ?
8. Explain why cyclic accelerators in general yield ion beam bursts and not continuous beams ?
9. What is meant by energy straggling? How does it affect the spectrum of ions scattered from a target ?
10. Explain any two applications of PIXE analysis technique.
11. Give a brief account of instrumentation of diffractometer.
12. What is structure factor ?

(12 × 1 = 12 weightage)

## Section B

*Answer any* **two** *questions.*

*Each question carries a weightage of* 6.

13. With the help of a neat diagram explain the various parts and working of a turbo molecular pump.

**Turn over**

14. Describe the experimental methods for the measurement of electrical conductivity of thin films. Define thermo electric power and its utility.

15. What is ion implantation ? Discuss how this process helps in obtaining a desired doping profile for a semiconductor. What are the main advantages and applications of ion implantation ?

16. Explain the principle of RBS technique. Draw and explain the experimental setup for the elemental analysis using this technique. What are the important applications of this method ?

(2 × 6 = 12 weightage)

## Section C

*Answer any* **four** *questions.*
*Each question carries a weightage of* 3.

17. In a pumping system, a diffusion pump with a pumping speed of 100 Torr litres $s^{-1}$ is backed by a rotary pump. The ultimate pressure achieved in the pumped chamber is $2.5 \times 10^{-5}$Torr. Calculate the pumping speed of the rotary pump.

18. A diamond tipped four point probe of in-line-type with probe spacing 0.5 mm is placed over a thin film sample deposited over an insulating substrate. A potential of IV is applied and the current was 0.5 mA. If the film thickness is 1 $\mu$ m, calculate the sheet resistance of the sample.

19. A cyclotron, operating at 5kV and a magnetic flux density of 0.8 Weber/$m^2$ accelerates alpha-particles to 2MeV. How long does it take to accelerate the particles from rest to this energy ?

20. The calibration constant for a particular trace element using PIXE setup was 2548 counts/$\mu$ g/$\mu$ C. For the internal standard element used with a concentration of 100 ppm, the corresponding value is 515. Evaluate the concentration of the trace element considered.

21. X-rays with wavelength 154.2pm produce reflections from the (110) and (200) planes of FCC Cu of density 8.935 g / $cm^3$. At what angles will these reflections appear ?

22. Derive the Scherrer equation.

(4 × 3 = 12 weightage)