

**2025/TDC(CBCS)/EVEN/SEM/
PHSDSE-601(A/B)/156**

TDC (CBCS) Even Semester Exam., 2025

PHYSICS

(6th Semester)

Course No. : PHSDSE-601

Full Marks : 70
Pass Marks : 28

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Candidates have to answer *either* from
Option—A or Option—B

OPTION—A

Course No. : PHSDSE-601 (A)

(Astronomy and Astrophysics)

UNIT—I

1. Answer any four of the following questions :

$1 \times 4 = 4$

- (a) What is the range of magnitude of a star
which can be seen without help of a
telescope?**

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(2)

- (b) Name the points of intersection of ecliptic and celestial equator.
- (c) Define spherical triangle.
- (d) Which great circle passes through the two poles?
- (e) What will be the zenith distance for the altitude A?

2. Answer any one of the following questions :

- (a) A sphere has how many great circles?
- (b) Write the values of declination of the celestial equator and pole.

3. Answer any one of the following questions :

- (a) Draw the celestial sphere and level zenith, nadir, celestial pole, celestial meridian, celestial equator and ecliptic. Explain briefly horizon system of coordinate with proper diagram. 4+4=8
- (b) What are apparent and absolute magnitude of a star? Derive the relation between them. The apparent magnitude of sun is -26.74, determine the absolute magnitude. 2+1+4+1=8

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UNIT-II

4. Answer any four of the following questions : $1 \times 4 = 4$

- (a) What will be the hour angle of a star when it is on the observers meridian?
- (b) What does the light gathering power of a telescope depend on?
- (c) What is the optical range of optical window?
- (d) What is f-ratio of a telescope?
- (e) Write about telescope mounting.

5. Answer any one of the following questions : 2

- (a) Draw and level Newtonian telescope.
- (b) Write two uses of detectors when they are used with telescopes.

6. Answer any one of the following questions : 8

- (a) Discuss in brief different types of reflecting telescopes.
- (b) Compare the advantages and disadvantages of reflecting telescopes.

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UNIT—III

7. Answer any four of the following questions :

 $1 \times 4 = 4$

- (a) What is the source of energy in the core of the sun?
- (b) What is the sequence of classification of stars?
- (c) What is the name of graph between the luminosity and effective temperature of stars?
- (d) What is the approximate temperature of the sunspot?
- (e) What is the value of the apparent magnitude of the sun?

8. Answer any one of the following questions:

2

- (a) Define solar flare.
- (b) Write down two salient features of blackbody spectrum.

9. Answer any one of the following questions :

8

- (a) Sketch H-R diagram and discuss briefly the various spectral classes of stars. Discuss about solar corona. $6+2=8$

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(5)

(b) Explain briefly the origin of solar system. Discuss the nebular model. $6+2=8$

UNIT—IV

10. Answer any four of the following as directed :

 $1 \times 4 = 4$

- (a) What are the typical size of a globular cluster?
- (b) Which class of the stars, does the central region of Milky Way contain?
- (c) The stars found in the disc of Milky Way are mostly population I stars.
(Write True or False)
- (d) What is the possible size of central bulge of our galaxy?
- (e) Write one property of Milky Way galaxy.

11. Answer any one of the following questions : 2

- (a) Define galactic halo.
- (b) Define rotation curve of a spiral galaxy.

12. Answer any one of the following questions : 8

- (a) Discuss Hubble's classification of galaxies.
- (b) Discuss different parts of the Milky Way galaxy with proper diagram.

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(6)

UNIT—V

13. Answer any four of the following as directed :

 $1 \times 4 = 4$

- (a) What is Cepheid variable?
- (b) Who is the father of Big Bang theory?
- (c) What is the distance of the venus from the earth?
- (d) What is the period of Cepheid variables?
- (e) Dark matter is experienced by the gravitational attraction.

(Write True or False)

14. Answer any one of the following questions :

2

- (a) What is virial theorem?
- (b) Define dark matter.

15. Answer any one of the following questions :

8

- (a) State and explain Hubble's law. What is the significance of Hubble's constant?
- (b) Write short notes on the following : $4 \times 2 = 8$
 - Ⓐ Big Bang theory
 - Ⓑ Cosmic distance ladder

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OPTION—B

Course No. : PHSDSE-601 (B)

(Nanomaterials and Applications)

UNIT—I

1. Answer any four of the following questions :

 $1 \times 4 = 4$

- (a) Why does band gap of material (nano) increase?
- (b) Which potential model explains quantum confinement in nano-dots?
- (c) Which nanostructure shows confinement in all three dimensions?
- (d) What is the typical range of nanoscale material?
- (e) What is the role of Schrödinger equation in analysing nanostructures?

2. Answer any one of the following questions :

2

- (a) How does quantum confinement influence the band structure and density of states in 1D, 2D and 3D?
- (b) How does decreasing nanostructure affect energy levels using infinite potential well model?

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3. Answer any one of the following questions : 8
- (a) Define 'length scales' in nanoscale systems. Differentiate between nano-dots and nano wires. Describe the effect of quantum confinement on optical and electronic properties of nanostructures with relevant examples. 2+2+4=8
- (b) Analyse how band structure and density of states change from bulk materials to nanostructures using diagrams.

UNIT-II

4. Answer any four of the following questions : 1×4=4
- (a) State the primary between top-down and bottom-up approaches in nanomaterial synthesis.
- (b) State the role of high-energy balls.
- (c) What is E-beam evaporation?
- (d) How do colloidal methods stabilize nanoparticles in a liquid medium?
- (e) Which nanofabrication technique uses UV light to transfer patterns into substrate?

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5. Answer any one of the following questions : 2
- (a) What is physical vapour deposition?
- (b) Mention two techniques used in PVD for nanomaterial synthesis.
6. Answer any one of the following questions : 8
- (a) Explain the principle of photolithography and mention its key applications in nanofabrication.
- (b) Explain the sol-gel process and discuss how it differs from chemical vapour deposition. Describe the process of ball milling and gas-phase condensation for nanoparticles synthesis. 4+4=8

UNIT-III

7. Answer any four of the following questions : 1×4=4
- (a) What is the primary difference between SEM and TEM?
- (b) What is hopping conductivity?
- (c) How do surface defects affect the electronic properties of nanomaterials?
- (d) What is Coulomb blockade?
- (e) How does STM achieve atomic-scale resolution?

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8. Answer any *one* of the following questions : 2

- (a) In SEM, what is the effect of increase of accelerating voltage?
- (b) For a nanoparticle of radius 3 nm, determine whether quantum tunnelling is significant if potential barrier is 5 eV and particle energy is 1 eV.

9. Answer any *one* of the following questions : 8

- (a) Explain the working principle of XRD and mention its significance in characterising nanostructure materials.
 - (b) Differentiate between tunnelling and hopping conductivity in nanostructures. Explain the working principle of atomic force microscopy.
- 4+4=8

UNIT—IV

10. Answer any *four* of the following questions : 1×4=4

- (a) What is an exciton?
- (b) What causes photoluminescence in semiconductor quantum dots?
- (c) How does band alignment in heterostructures influence optical absorptions and emission?

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(d) Why does dielectric constant decrease as material size approaches the nanoscale? 2

(e) What is quantum confinement in nanocrystals?

11. Answer any *one* of the following questions : 2

- (a) A quantum dot emits light at 550 nm. Calculate the energy of emitted photon in eVs.
- (b) Coulomb interaction influences exciton formation in semiconductor nanocrystals. How?

12. Answer any *one* of the following questions : 8

- (a) Discuss the radiative processes in nanostructures focussing on absorption, emission and luminescence.
- (b) What are excitons? Differentiate between excitons in direct and indirect band gap semiconductor nanocrystals. Explain the role of dielectric constant in nano structure and its effect on Coulomb interaction.

UNIT—V

13. Answer any *four* of the following questions : 1×4=4

- (a) How do quantum dots enhance the efficiency of solar cells?

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- (b) State the principle behind single-electron transfer devices.
- (c) What is the significance of magnetic quantum wells in spintronic devices?
- (d) What is the key difference between MEMS and NEMS?
- (e) Mention one application of carbon nanotube.

14. Answer any *one* of the following questions : 2

- (a) What are the uses of nanowires?
- (b) Give one example of MEMS and NEMS each.

15. Answer any *one* of the following questions : 8

- (a) Explain the working principle of CNT-based transistors and highlight one of their advantages over conventional transistors.
- (b) Explain the working of quantum dot heterostructure lasers. How are optical switching and optical data storage achieved using nanomaterials? 4+4=8

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