BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: IMSc/MSc **SEMESTER : IX/III**
BRANCH: PHYSICS **SESSION : MO/2024**

SUBJECT: PH505 THEORY OF SOLIDS

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Obtain the tight-binding Hamiltonian for a 2D square lattice with nearest neighbor hopping and the corresponding energy dispersion E(k).	[5]	1	3
Q.1(b)	Show that the low energy dispersion around $\Gamma = (0,0)$ and $M = (\pi, \pi)$ is quadratic, $E(q) \sim q^2$.	[5]	1	2
Q.2(a)	What is Fermi energy? Does it depend on temperature?	[2]	2	2
Q.2(b)	What is Fermi-Dirac distribution? Discuss its temperature dependence with a plot.	[3]	2	2
Q.2(c)	What is density of states? Classify materials based on density of states and electronic bandgaps.	[5]	2	3
Q.3(a)	Outline the characteristics of ferroelectric materials? Draw the corresponding hysteresis curve, label all the points and discuss key aspects.	[5]	3	2
Q.3(b)	What is polarization? Discuss different types of polarization?	[5]	3	2
Q.4(a)	What is magnetic frustration? Discuss its origin with suitable examples.	[4]	4	3
Q.4(b)	Set up the Hubbard Hamiltonian for the hydrogen molecule in a triplet state after defining a suitable basis.	[6]	4	3
Q.5(a)	Write the prescription to include the light-matter interaction in a model Hamiltonian. Discuss the importance of various terms.	[3]	5	2
Q.5(b)	What is the dipole approximation?	[2]	5	2
Q.5(c)	Discuss the direct (inter-band) optical transitions using the Fermi-Golden rule.	[5]	5	3

::::::22/11/2024::::::E