هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T4
2020

Course Specifications

Course Title:	**Introduction to superconducting materials**
Course Code:	**2034214-2**
Program:	**Bachelor in Physics**
Department:	**Physics Department**
College:	**College of Science**
Institution:	**Taif University**

Table of Contents

A. Course Identification

1. Credit hours: 2	
2. Course type	
a. University ☐ College ☑ (√) Department ☐ Others ☐	
b. Required ☐ Elective ☑ (√)	
3. Level/year at which this course is offered:	**11th level / 4th year**
4. Pre-requisites for this course (if any)**: NONE**	
5. Co-requisites for this course (if any)**: NONE**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	3	100%
2	**Blended**		
3	**E-learning**		
4	**Distance learning**		
5	**Other**		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	**Lecture**	30
2	**Laboratory/Studio**	0
3	**Tutorial**	0
4	**Others** (specify)	0
	Total	**30**

B. Course Objectives and Learning Outcomes

1. Course Description

The course begins with a description of the changes in the properties of metals on becoming superconducting. The thermodynamics of the associated phase transition is then elucidated. The theoretical treatment starts with the phenomenological Ginzburg-Landau approach and is followed by the microscopic theory of superconductivity due to Bardeen, Cooper and Schrieffer (BCS). The theoretical understanding is used to explain tunneling and quantum interference phenomena in superconductors. Following this, some of the experimental methods for probing the superconducting state are also described. Finally, various superconductors, including high-Tc, which do not appear to follow the BCS theory, are discussed.

2. Course Main Objective

The course aims at giving the students in depth knowledge and know-how within the theory of superconductivity in order to understand and describe the principles behind various superconducting applications.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	Memories different theories of superconductivity and their ranges of validity	K2
1.2	Recognize the difference between good conductors, perfect conductors and superconductors	K3
2	**Skills :**	
2.1	Apply London theory, modified London theory and Ginzburg-Landau theory for superconductivity for both derivations and numerical calculations	S1
2.2	Explain type-I and type-II superconductivity based on thermodynamic calculations of the Gibbs free energy for a superconductor	S4
3	**Values:**	
3.1	Show responsibility for working independently and for continuous improvement of personal capacities.	V1
3.2	Assess various applications of superconductivity	

C. Course Content

No	List of Topics	Contact Hours
1	A historical overview: Superconductivity in Hg, cuprates, MgB2 and Fe pnictides	1
2	Basic properties of metals in normal state: Resistivity, electronic and phonon specific heats, thermal conductivity, magnetic susceptibility and Hall effect.	2
3	Phenomenon of superconductivity: Zero resistance, persistent currents, superconducting transition temperature Tc , isotope effect, perfect diamagnetism and Meissner effect, penetration depth and critical field.	3
4	Thermodynamics of superconducting transition: First-order and second-order transition, specific heat above and below Tc , thermal conductivity.	3
5	Phenomenological theory of superconductivity: Free energy, order parameter, GinzburgLandau equations, predictions of Ginzburg- Landau equations, flux-quantization, penetration depth.	3
6	Microscopic theory of superconductivity: Electron-phonon interaction, Cooper pairs, Bardeen-Cooper-Schrieffer (BCS) Hamiltonian, variation approach, canonical transformation, finite temperatures, properties of the BCS ground state, macroscopic properties of superconductors. 6 7. Tunneling and the ene.	3
7	Tunneling and the energy gap: Tunneling phenomenon, energy-level diagram, Josephson effect, quantum interference	3
8	Type-I and Type-II superconductivity: Type-I and type-II superconductors, intermediate states, mixed states.	3
9	Experimental methods for probing the nature of the superconducting state: Nuclear magnetic resonance and Knight shift, planar, scanning and point-	3

	contact spectroscopy.	
10	Unconventional superconductors: Heavy-fermion superconductors, metaloxide superconductors, organic superconductors, magnesium diboride, iron pnictides.	3
11	Basics of High-Tc superconductivity.	3
Total		30

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Memories different theories of superconductivity and their ranges of validity	Lecture	Written exam and Homework reports
1.2	Recognize the difference between good conductors, perfect conductors and superconductors	Lecture and Group discussion	Written exam
2.0	**Skills**		
2.1	Apply London theory, modified London theory and Ginzburg-Landau theory for superconductivity for both derivations and numerical calculations	Lectures	Written exam and Homework reports
2.2	Explain type-I and type-II superconductivity based on thermodynamic calculations of the Gibbs free energy for a superconductor	Lecture and Group discussion	Homework reports
3.0	**Values**		
3.1	Show responsibility for working independently and for continuous improvement of personal capacities.	Group discussion	Project
3.2	Assess various applications of superconductivity	Groups discussion	Homework reports and projects

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Assignments and Interaction during lectures	continuous	10%
2	Midterm exam	6th	30%
3	Short exam	9th	10%
4	Final exam	12th	50%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice : 6 Hours per week during office-hours, in teacher's staffroom or as per the arrangement made by the teacher.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	1. C. Kittel, "Introduction to Solid State Physics", 7 th Edition, John Wiley & Sons, Inc., Singapore (1995). 2. A.C. Rose-Innes and E.H. Rhoderick, "Introduction to Superconductivity", 2 nd Edition, Pergammon, Oxford (1978).
Essential References Materials	1- M. Tinkham, "Introduction to Superconductivity", 2 nd Edition, Dover Publications, Inc., New York (1996). 2- P.G. de Gennes, "Superconductivity in Metals and Alloys", W.A. Benjamin, New York (1966). 3-C.P. Poole Jr., H.A. Farach, R.J. Creswick, and R. Prozorov, "Superconductivity", 2nd Edition, Academic Press (2007).
Electronic Materials	1- http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
Other Learning Materials	1- Multi media / CD associated with the text books (when available).

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Lecture room with max 60 seats Labs
Technology Resources (AV, data show, Smart Board, software, etc.)	data show, Smart Board, software
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	NON

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Student Feedback on Effectiveness of Teaching	Students	Indirect
Evaluation of Teaching	Pear reviewer Program coordinator Departmental council Faculty council	Indirect
Improvement of Teaching	Program coordinator Relevant committee	Direct

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Quality of learning resources	Students Instructor Faculty	Indirect
Extent of achievement of course learning outcomes,	Program coordinator Instructor	Direct
Course effectiveness and planning for improvement	Program coordinator Instructor	Indirect

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	Department Council / Committee of academic development
Reference No.	
Date	October 2, 2022