Course Specification

(Postgraduate Programs)

Course Title:	**Advanced Physical Chemistry**
Course Code:	**CHM 6141**
Program:	**Master of science in chemistry**
Department:	**Chemistry**
College:	**Science**
Institution:	: Imam Mohammad Ibn Saud Islamic University
Version:	*Course Specification Version Number*
Last Revision Date:	*Pick Revision Date.*

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A. General information about the course:

1. Course Identification:

1. Credit hours: (.....)
4 (4 Lectures, 0 Lab, 0 Tutorials)

2. Course type					
A.	☐University	☐College	☐Department	☐Track	
B.	☒ Required		☐Elective		

3. Level/year at which this course is offered: (Level 2/ Year 1)

4. Course General Description:
This course is provided a comprehensive treatment of physical chemistry for advanced students in a reasonable manner. It will cover all important and advanced topics in physical chemistry. This course explores materials and materials processes from the perspective of thermodynamics and kinetics. The thermodynamics aspect includes laws of thermodynamics, solution theory and equilibrium diagrams. The kinetics aspect includes diffusion, phase transformations, and the development of microstructure.

5. Pre-requirements for this course (if any):
None

6. Pre-requirements for this course (if any):
None

7. Course Main Objective(s):
• **Know, the basic principles of physical chemistry, in particular, Kinetics, Thermodynamics and Materials Science.** • Describe the advanced principles of thermodynamic, and classical thermodynamics. • Be familiar with materials and materials processes from the perspective of thermodynamics and kinetics. • Familiarize the classifications of materials, solid solutions, alloys, phase diagrams, composites, advanced materials. Recognize the different application of materials in the industry: metallurgical industry.

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom		

No	Mode of Instruction	Contact Hours	Percentage
	• E-learning		
4	Distance learning		

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	60
2.	**Laboratory/Studio**	0
3.	**Field**	0
4.	**Tutorial**	0
5.	**Others (specify)……**	0
	Total	60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

1. ***Inorganic Chemistry Track***

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**To recall knowledge of Classical Physical Chemistry and Chemical Kinetics Concepts.**	**K1. *Inorg.*; K4. *Inorg***	▪ Five hours/week lectures. ▪ Self-study Home-exam.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion Participation.
1.2	**To list and memorize different concepts of Thermodynamic Laws and the Physical Properties of Materials**	**K2. *Inorg.*; K4. *Inorg***	▪ Five hours/week lectures. ▪ Think, to justify thermodynamic laws and the physical properties of materials, using available references (SDL) online. Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.3	**To record the Statistical Thermodynamics.**	**K4. *Inorg***	▪ Five hours/week lectures. Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. Participation.
1.4	**To describe Materials and Materials Processes from the Perspective of Thermodynamics and Kinetics.**	**K1. *Inorg.*; K2. *Inorg***	▪ Five hours/week lectures. Group Discussion on materials processes thermodynamically and kinetically using available references (SDL) online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. Participation.
2.0	**Skills**			
2.1	**To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate Thermodynamics Laws and Kinetics Laws.**	**S1. *Inorg.*; S2. *Inorg***	▪ Lectures activity ▪ Self-study. Deep discussion on the appropriate thermodynamics laws and kinetics laws approaches.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation Mini -seminar.
2.2	**To interpret the catalytic reactions on variation operational conditions and contrast scientific data on materials and arguments clearly and correctly.**	**S1. *Inorg.*; S2. *Inorg.*; S3. *Inorg.***	▪ Practice examples of the interpretation of the catalytic reactions for a variety of operational conditions achieving. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion Short Quizzes.
2.3	**To illustrate reasonable arguments for classifications of materials, solid solutions, alloys, phase diagrams, composites, and advanced materials.**	**S2. *Inorg.*; S3. *Inorg.***	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. Participation.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
2.4	**To demonstrate Oral Communication on application of development of microstructure and material science in the industry: and its impact in KSA, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	**S1. *Inorg.*; S3. *Inorg.*; S4. *Inorg.***	▪ Group Discussion and Assignments ▪ Suggest examples micro-structure and material science in the industry and its impact in KSA, which will require reading, writing, and oral presentation. Encourage students to use electronic mail to submit Home Exams and Assignments.	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures. Marks given for Assignments
3.0	**Values, autonomy, and responsibility**			
3.1	**To Perform communications to integrity, academic ethical practices to find solutions for scientific and social issues, and a commitment to responsible citizenship and using IT.**	**V1. *Inorg.***	▪ Brain Storms Exercises Group Discussion.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To Appraise effectively in research or professional groups and make decisions, develop knowledge, enhance society's quality, and contribute to its advancement.**	**V1. *Inorg.*; V2. *Inorg.***	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. Group Presentation of mini-projects.	▪ Participation ▪ Homework's Mini-project(s).
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2. Organic Chemistry Track

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.1	**To recall knowledge of Classical Physical Chemistry and Chemical Kinetics Concepts.**	**K1. *Org.*; K2. *Org***	▪ Five hours/week lectures. ▪ Self-study Home-exam.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion Participation.
1.2	**To list and memorize different concepts of Thermodynamic Laws and the Physical Properties of Materials**	**K2. *Org.*; K4. *Org.***	▪ Five hours/week lectures. ▪ Think, to justify thermodynamic laws and the physical properties of materials, using available references (SDL) online. Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To record the Statistical Thermodynamics.**	**K2. *Org.***	▪ Five hours/week lectures. Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. Participation.
1.4	**To describe Materials and Materials Processes from the Perspective of Thermodynamics and Kinetics.**	**K1. *Org.*; K2. *Org.*; K3. *Org.***	▪ Five hours/week lectures. Group Discussion on materials processes thermodynamically and kinetically using available references (SDL) online.	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey ▪ Mini-seminar. Participation.
2.0	**Skills**			
2.1	**To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate Thermodynamics Laws and Kinetics Laws.**	**S1. *Org.***	▪ Lectures activity ▪ Self-study. Deep discussion on the appropriate thermodynamics laws and kinetics laws approaches.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation Mini -seminar.
2.2	**To interpret the catalytic reactions on variation operational**	**S1. *Org.*; S2. *Org.*; S3. *Org.***	▪ Practice examples of the interpretation of	▪ Questions in Lectures. ▪ Participation

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	conditions and contrast scientific data on materials and arguments clearly and correctly.		the catalytic reactions for a variety of operational conditions achieving. ▪ Brainstorming. Self-study	▪ Oral Discussion Short Quizzes.
2.3	**To illustrate reasonable arguments for classifications of materials, solid solutions, alloys, phase diagrams, composites, and advanced materials.**	**S1. *Org.*; S2. *Org.*; S3. *Org.***	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. Participation.
2.4	**To demonstrate Oral Communication on application of development of microstructure and material science in the industry: and its impact in KSA, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	**S1. *Org.*; S3. *Org.*; S4. *Org.***	▪ Group Discussion and Assignments ▪ Suggest examples micro-structure and material science in the industry and its impact in KSA, which will require reading, writing, and oral presentation. Encourage students to use electronic mail to submit Home Exams and Assignments.	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures. Marks given for Assignments
3.0	**Values, autonomy, and responsibility**			
3.1	**To Perform communications to integrity, academic ethical practices to find solutions for scientific and social issues, and a commitment to responsible citizenship and using IT.**	**V1. *Org.***	▪ Brain Storms Exercises Group Discussion.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
3.2	**To Appraise effectively in research or professional groups and make decisions, develop knowledge, enhance society's quality, and contribute to its advancement.**	**V1. *Org.*; V2. *Org.***	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. Group Presentation of mini-projects.	▪ Participation ▪ Homework's Mini-project(s).
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3. *Analytical Chemistry Track*

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**To recall knowledge of Classical Physical Chemistry and Chemical Kinetics Concepts.**	**K1. *Anal.*; K4. *Anal.***	▪ Five hours/week lectures. ▪ Self-study Home-exam.	▪ Regular Exams ▪ Assignments ▪ Short Quizzes ▪ Oral Discussion Participation.
1.2	**To list and memorize different concepts of Thermodynamic Laws and the Physical Properties of Materials**	**K1. *Anal.*; K4. *Anal.*;**	▪ Five hours/week lectures. ▪ Think, to justify thermodynamic laws and the physical properties of materials, using available references (SDL) online. Open discussion.	▪ Oral Discussion marks ▪ Literatures Survey ▪ Mini-seminar. ▪ Participation.
1.3	**To record the Statistical Thermodynamics.**	**K4. *Anal.***	▪ Five hours/week lectures. Group Discussion using available references (SDL) online.	▪ Midterm. ▪ Assignments. ▪ Group Discussions. ▪ Literatures Survey ▪ Mini-seminar. Participation.
1.4	**To describe Materials and Materials Processes from the Perspective of**	**K1. *Anal.*; K4. *Anal.***	▪ Five hours/week lectures. Group Discussion on materials processes	▪ Assignments ▪ Open Discussions. ▪ Literatures Survey

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	Thermodynamics and Kinetics.		thermodynamically and kinetically using available references (SDL) online.	▪ Mini-seminar. Participation.
2.0	**Skills**			
2.1	**To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate Thermodynamics Laws and Kinetics Laws.**	**S1. *Anal.*; S2. *Anal.***	▪ Lectures activity ▪ Self-study. Deep discussion on the appropriate thermodynamics laws and kinetics laws approaches.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation Mini -seminar.
2.2	**To interpret the catalytic reactions on variation operational conditions and contrast scientific data on materials and arguments clearly and correctly.**	**S1. *Anal.*; S2. *Anal.*; S3. *Anal.***	▪ Practice examples of the interpretation of the catalytic reactions for a variety of operational conditions achieving. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion Short Quizzes.
2.3	**To illustrate reasonable arguments for classifications of materials, solid solutions, alloys, phase diagrams, composites, and advanced materials.**	**S1. *Anal.*; S2. *Anal.*; S3. *Anal.***	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. Participation.
2.4	**To demonstrate Oral Communication on application of development of microstructure and material science in the industry: and its impact in KSA, accompanying writing of mini- Reports, operating electronic mail, and Network in**	**S1. *Anal.*; S3. *Anal.*; S4. *Anal.***	▪ Group Discussion and Assignments ▪ Suggest examples micro-structure and material science in the industry and its impact in KSA, which will require reading, writing, and oral presentation.	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures. Marks given for Assignments

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	communicating with others.		Encourage students to use electronic mail to submit Home Exams and Assignments.	
3.0	**Values, autonomy, and responsibility**			
3.1	**To Perform communications to integrity, academic ethical practices to find solutions for scientific and social issues, and a commitment to responsible citizenship and using IT.**	**V1. *Anal.***	▪ Brain Storms Exercises Group Discussion.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To Appraise effectively in research or professional groups and make decisions, develop knowledge, enhance society's quality, and contribute to its advancement.**	**V1. *Anal.*; V2. *Anal.***	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. Group Presentation of mini-projects.	▪ Participation ▪ Homework's Mini-project(s).
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4. *Physical Chemistry Track*

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**To recall knowledge of Classical Physical Chemistry and Chemical Kinetics Concepts.**	**K1. *Phy.*; K2. *Phy.*; K3. *Phy.*; K4. *Phy***	▪ Brain Storms Exercises Group Discussion.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
1.2	**To list and memorize different concepts of Thermodynamic Laws**	**K1. *Phy.*; K2. *Phy.*; K3. *Phy.*;**	▪ Small Group tasks ▪ Open discussion at classroom.	▪ Participation ▪ Homework's Mini-project(s).

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	and the Physical Properties of Materials		▪ Office hour guiding. Group Presentation of mini-projects.	
1.3	**To record the Statistical Thermodynamics.**	**K1. *Phy*.**	▪ Brain Storms Exercises Group Discussion.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
1.4	**To describe Materials and Materials Processes from the Perspective of Thermodynamics and Kinetics.**	**K1. *Phy*.; K2. *Phy*.; K4. *Phy*.**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. Group Presentation of mini-projects.	▪ Participation ▪ Homework's Mini-project(s).
2.0	**Skills**			
2.1	**To analyze problems and explore strategies for their solution, with justify the optimum approaches to appropriate Thermodynamics Laws and Kinetics Laws.**	**S1. *Phy*.; S2. *Phy*.; S3. *Phy*.**	▪ Lectures activity ▪ Self-study. Deep discussion on the appropriate thermodynamics laws and kinetics laws approaches.	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Open Discussions. ▪ Participation Mini -seminar.
2.2	**To interpret the catalytic reactions on variation operational conditions and contrast scientific data on materials and arguments clearly and correctly.**	**S1. *Phy*.; S2. *Phy*.; S3. *Phy*.**	▪ Practice examples of the interpretation of the catalytic reactions for a variety of operational conditions achieving. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Participation ▪ Oral Discussion Short Quizzes.
2.3	**To illustrate reasonable arguments for classifications of materials, solid solutions, alloys, phase diagrams, composites,**	**S1. *Phy*.; S2. *Phy*.; S3. *Phy*.; S4. *Phy*.;**	▪ Lectures ▪ Oral Discussions. ▪ Brainstorming. Self-study	▪ Questions in Lectures. ▪ Short Quizzes and Exams. ▪ Oral Discussion. Participation.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	and advanced materials.			
2.4	**To demonstrate Oral Communication on application of development of microstructure and material science in the industry: and its impact in KSA, accompanying writing of mini- Reports, operating electronic mail, and Network in communicating with others.**	**S1. *Phy.*; S2. *Phy.*; S4. *Phy.***	▪ Group Discussion and Assignments ▪ Suggest examples micro-structure and material science in the industry and its impact in KSA, which will require reading, writing, and oral presentation. Encourage students to use electronic mail to submit Home Exams and Assignments.	▪ Oral Discussion. ▪ Quizzes, and Exams. ▪ Giving marks for Oral Discussion in Lectures. Marks given for Assignments
3.0	**Values, autonomy, and responsibility**			
3.1	**To Perform communications to integrity, academic ethical practices to find solutions for scientific and social issues, and a commitment to responsible citizenship and using IT.**	**V1. *Phy.***	▪ Brain Storms Exercises Group Discussion.	▪ Oral Discussion. ▪ Group Discussion ▪ Assignments.
3.2	**To Appraise effectively in research or professional groups and make decisions, develop knowledge, enhance society's quality, and contribute to its advancement.**	**V1. *Phy.*; V2. *Phy.*;**	▪ Small Group tasks ▪ Open discussion at classroom. ▪ Office hour guiding. Group Presentation of mini-projects	▪ Participation ▪ Homework's Mini-project(s).
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C. Course Content:

No	List of Topics	Contact Hours
1.	***Kinetics:*** ***Introduction***, The Rate Equation and Rate Laws, Reactions and Thermodynamic Equilibrium, Temperature Dependence of the Rate, ***Integrated Rate Equations***, Time Dependence of Concentrations in Reactions of Different Orders, ***Coupled Reactions in Flow Reactors***, The Steady-state Approximation, Coupled Reactions in Batch Reactors, ***Catalytic Reactions,*** Langmuir Adsorption Isotherms, Competitive Adsorption.	22
2.	***Thermodynamics*** ***General Introduction***: Classical thermodynamics: the first law of thermodynamics, ***Classical thermodynamics revisited:*** the second and third law of thermodynamics, ***Basic probability theory***, The Boltzmann distribution, ***Ensembles in statistical thermodynamics and partition function***, Calculation of state functions, Kinetic theory of gases, Lifson-Roig theory.	18
3.	***Materials Science*** I***ntroduction***, the classifications of materials, solid solutions, alloys, phase diagrams, ***Composites***, advanced materials, the determination of the crystal structures, crystal imperfections, X-ray Diffractions, ***Physical, optical properties***, LASER, electrical, thermal, magnetic and mechanical properties of materials, ***interaction of radiation with the matter***, applications of materials in the industry: metallurgical industry.	20
4.		
5.		
6.		
7.		
8.		
Total		60

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Class Activities (Open Discussion, Mini-reports, Oral Presentation, solving questions)	weekly	30 %
2.	Midterm Exam	9 th week	30 %
3.	Final Exam	Around	40 %

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
		17th week	
...	Total		100%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	***Concepts of Modern Catalysis and Kinetics,*** Chorkendorff, I.; Niemantsverdriet, J. W., Wiley-VCH, 2003. ***Thermodynamics, Statistical Thermodynamics and*** Kinetics. Engel, Th., Reid, Ph., Pearson, Boston, 3rd edition. 2012. ISBN-10: 0321766180
Supportive References	***None***
Electronic Materials	• The Journal of Physical Chemistry A • The Journal of Physical Chemistry B • The Journal of Physical Chemistry C • The Journal of Physical Chemistry • The Journal of Physical and Colloid Chemistry • The Journal of Physical Chemistry Letters Saudi Digital Library
Other Learning Materials	• Blackboard Multimedia associated with the text book and the relevant websites

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**Each of the classroom should be equipped with a whiteboard and a projector, with a maximum of 20 students.**
Technology equipment (Projector, smart board, software)	**The rooms are equipped with data show, Smart Board, WI-FI access.**
Other equipment (Depending on the nature of the specialty)	**None**

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	**Direct:** Questionnaire.
	Course Responsible	**Direct:** Course e-Portfolio.

Assessment Areas/Issues	Assessor	Assessment Methods
		Indirect: Second examiner checklist-Course report.
	Peer Reviewer	**Direct:** Questionnaire. **Indirect:** External assessor report.
Effectiveness of students' assessment	Program Leaders	**Direct:** Course e-Portfolio. **Indirect:** Course report.
Quality of learning resources	Students	**Indirect:** Second examiner checklist-Course report.
	Faculty (Academic Advisory-GCC)	**Direct:** course Entrance/Exit. **Indirect:** Observations - Accreditation review.
	Program Leaders	**Direct:** Course e-Portfolio.
	Course Responsible	**Indirect:** Course evaluation survey- Observations- Syllabus review- Accreditation review.
The extent to which CLOs have been achieved	Students	**Direct:** Exams - Course e-Portfolio. **Indirect:** Second examiner checklist-Course report.
	Program Leaders	**Indirect:** Exams.
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	**Council of Chemistry Department**
REFERENCE NO.	**10 (No. 2/10)**
DATE	**21/04/1444- 15/11/2022**