

Enquiry for Course Details

CHEM4142 Symmetry, group theory and applications (6 credits)		Academic Year	2020
Offering Department	Chemistry	Quota	60
Course Co-ordinator	Prof V W W Yam, Chemistry < wwyam@hku.hk >		
Teachers Involved	(Dr S M Tong, Chemistry) (Prof V W W Yam, Chemistry)		
Course Objectives	To introduce the concepts of symmetry and group theory and to apply them in solving chemical problems. This course also provides an introductory treatment of bonding theories, inorganic electronic and vibrational spectroscopy. This course is essential for students who wish to take advanced courses in inorganic chemistry and all types of spectroscopy.		
Course Contents & Topics	Symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; hybrid orbitals; molecular orbital theory for organic, inorganic and organometallic systems; selected applications in electronic and vibrational spectroscopy.		
Course Learning Outcomes	On successful completion of this course, students should be able to:		
	CLO 1	understand the basic principles and concepts of symmetry and group theory and to apply them in solving chemical problems	
	CLO 2	demonstrate knowledge and understanding in the use of character tables and projection operator techniques	
	CLO 3	demonstrate knowledge and understanding of bonding theories involving hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems	
	CLO 4	demonstrate knowledge and understanding in the application of symmetry and group theory in electronic and vibrational spectroscopy	
Pre-requisites (and Co-requisites and Impermissible combinations)	Pass in CHEM3341		
Course Status with Related Major/Minor /Professional Core	2020 Major in Chemistry (Disciplinary Elective) 2020 Major in Chemistry (Intensive) (Core/Compulsory) 2020 Minor in Chemistry (Disciplinary Elective) 2019 Major in Chemistry (Disciplinary Elective) 2019 Major in Chemistry (Intensive) (Core/Compulsory) 2019 Minor in Chemistry (Disciplinary Elective) 2018 Major in Chemistry (Disciplinary Elective) 2018 Major in Chemistry (Intensive) (Core/Compulsory) 2018 Minor in Chemistry (Disciplinary Elective) 2017 Major in Chemistry (Disciplinary Elective) 2017 Major in Chemistry (Intensive) (Core/Compulsory) 2017 Minor in Chemistry (Disciplinary Elective) 2016 Major in Chemistry (Disciplinary Elective) 2016 Major in Chemistry (Intensive) (Core/Compulsory) 2016 Minor in Chemistry (Disciplinary Elective)		
Course to PLO Mapping	2020 Major in Chemistry < PLO 2,3,4 > 2020 Major in Chemistry (Intensive) < PLO 2,3,4 > 2019 Major in Chemistry < PLO 2,3,4 > 2019 Major in Chemistry (Intensive) < PLO 2,3,4 > 2018 Major in Chemistry < PLO 2,3,4 > 2018 Major in Chemistry (Intensive) < PLO 2,3,4 > 2017 Major in Chemistry < PLO 2,3,4 > 2017 Major in Chemistry (Intensive) < PLO 2,3,4 > 2016 Major in Chemistry < PLO 2,3,4 > 2016 Major in Chemistry (Intensive) < PLO 2,3,4 >		
Offer in 2020 - 2021	Y	1st sem	Examination Dec
Offer in 2021 - 2022	Y		
Course Grade	A+ to F		

Grade Descriptors	<table border="1"> <tr> <td data-bbox="617 155 706 365">A</td> <td data-bbox="706 155 1448 365">Demonstrate thorough knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show strong ability to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show strong ability to analyze novel problems and critical use of data and experimental results to draw appropriate and insightful conclusions relating to the principles and applications of symmetry and group theory.</td> </tr> <tr> <td data-bbox="617 365 706 575">B</td> <td data-bbox="706 365 1448 575">Demonstrate substantial command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show evidence to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show evidence to analyze novel problems and correct use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.</td> </tr> <tr> <td data-bbox="617 575 706 827">C</td> <td data-bbox="706 575 1448 827">Demonstrate general but incomplete command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show evidence of some abilities to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show ability to analyze problems to most familiar situations and mostly correct but erroneous use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.</td> </tr> <tr> <td data-bbox="617 827 706 1058">D</td> <td data-bbox="706 827 1448 1058">Demonstrate partial but limited command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show evidence of limited abilities to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show limited ability to analyze problems to most familiar situations and mostly correct but erroneous use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.</td> </tr> <tr> <td data-bbox="617 1058 706 1276">Fail</td> <td data-bbox="706 1058 1448 1276">Demonstrate little or no evidence of command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show little or no evidence of abilities to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show little or no ability to analyze problems to most familiar situations and erroneous use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.</td> </tr> </table>	A	Demonstrate thorough knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show strong ability to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show strong ability to analyze novel problems and critical use of data and experimental results to draw appropriate and insightful conclusions relating to the principles and applications of symmetry and group theory.	B	Demonstrate substantial command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show evidence to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show evidence to analyze novel problems and correct use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.	C	Demonstrate general but incomplete command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show evidence of some abilities to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show ability to analyze problems to most familiar situations and mostly correct but erroneous use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.	D	Demonstrate partial but limited command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show evidence of limited abilities to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show limited ability to analyze problems to most familiar situations and mostly correct but erroneous use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.	Fail	Demonstrate little or no evidence of command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show little or no evidence of abilities to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show little or no ability to analyze problems to most familiar situations and erroneous use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.						
A	Demonstrate thorough knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show strong ability to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show strong ability to analyze novel problems and critical use of data and experimental results to draw appropriate and insightful conclusions relating to the principles and applications of symmetry and group theory.																
B	Demonstrate substantial command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show evidence to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show evidence to analyze novel problems and correct use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.																
C	Demonstrate general but incomplete command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show evidence of some abilities to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show ability to analyze problems to most familiar situations and mostly correct but erroneous use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.																
D	Demonstrate partial but limited command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show evidence of limited abilities to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show limited ability to analyze problems to most familiar situations and mostly correct but erroneous use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.																
Fail	Demonstrate little or no evidence of command of knowledge and understanding of essential facts, concepts, principles, and theories relating to symmetry and group theory and their applications in solving chemical problems, especially those related to symmetry elements and symmetry operations; symmetry point groups; reducible and irreducible representations; character tables; direct products; symmetry-adapted linear combinations; projection operators; treatment of bonding theories including hybrid orbitals and molecular orbitals for organic, inorganic and organometallic systems; and applications in electronic and vibrational spectroscopy. Show little or no evidence of abilities to apply and integrate knowledge and theory relating to the basic principles and concepts of symmetry and group theory and their applications in bonding, and electronic and vibrational spectroscopy. Show little or no ability to analyze problems to most familiar situations and erroneous use of data and experimental results to draw appropriate conclusions relating to the principles and applications of symmetry and group theory.																
Course Type	Lecture-based course																
Course Teaching & Learning Activities	<table border="1"> <thead> <tr> <th data-bbox="617 1329 964 1360">Activities</th> <th data-bbox="964 1329 1265 1360">Details</th> <th data-bbox="1265 1329 1448 1360">No. of Hours</th> </tr> </thead> <tbody> <tr> <td data-bbox="617 1360 964 1392">Lectures</td> <td data-bbox="964 1360 1265 1392"></td> <td data-bbox="1265 1360 1448 1392">36</td> </tr> <tr> <td data-bbox="617 1392 964 1434">Tutorials</td> <td data-bbox="964 1392 1265 1434">or discussion</td> <td data-bbox="1265 1392 1448 1434">12</td> </tr> <tr> <td data-bbox="617 1434 964 1476">Reading / Self study</td> <td data-bbox="964 1434 1265 1476"></td> <td data-bbox="1265 1434 1448 1476">100</td> </tr> </tbody> </table>	Activities	Details	No. of Hours	Lectures		36	Tutorials	or discussion	12	Reading / Self study		100				
Activities	Details	No. of Hours															
Lectures		36															
Tutorials	or discussion	12															
Reading / Self study		100															
Assessment Methods and Weighting	<table border="1"> <thead> <tr> <th data-bbox="617 1486 743 1518">Methods</th> <th data-bbox="743 1486 1044 1518">Details</th> <th data-bbox="1044 1486 1224 1539">Weighting in final course grade (%)</th> <th data-bbox="1224 1486 1448 1539">Assessment Methods to CLO Mapping</th> </tr> </thead> <tbody> <tr> <td data-bbox="617 1539 743 1581">Assignments</td> <td data-bbox="743 1539 1044 1581"></td> <td data-bbox="1044 1539 1224 1581">15</td> <td data-bbox="1224 1539 1448 1581">CLO 1,2,3,4</td> </tr> <tr> <td data-bbox="617 1581 743 1623">Examination</td> <td data-bbox="743 1581 1044 1623"></td> <td data-bbox="1044 1581 1224 1623">60</td> <td data-bbox="1224 1581 1448 1623">CLO 1,2,3,4</td> </tr> <tr> <td data-bbox="617 1623 743 1665">Test</td> <td data-bbox="743 1623 1044 1665"></td> <td data-bbox="1044 1623 1224 1665">25</td> <td data-bbox="1224 1623 1448 1665">CLO 1,2,3,4</td> </tr> </tbody> </table>	Methods	Details	Weighting in final course grade (%)	Assessment Methods to CLO Mapping	Assignments		15	CLO 1,2,3,4	Examination		60	CLO 1,2,3,4	Test		25	CLO 1,2,3,4
Methods	Details	Weighting in final course grade (%)	Assessment Methods to CLO Mapping														
Assignments		15	CLO 1,2,3,4														
Examination		60	CLO 1,2,3,4														
Test		25	CLO 1,2,3,4														
Required/recommended reading and online materials	F.A. Cotton: Chemical Applications of Group Theory (Wiley, 3rd ed., 1990)																
Course Website	NIL																
Additional Course Information	This course is also offered to RPg students, and the course code for RPg students is CHEM6116.																

← Back / 🏠 Home