PORTOFOLIO
QUANTUM CHEMISTRY

ACADEMIC YEAR 2019/2020 EVEN SEMESTER

Course Coordinator:
Prof. Dr. Suyono, M.Pd.

Teaching Team:
Dr. I Gusti Made Sanjaya, M.Si.

CHEMISTRY DEPARTMENT

FACULTY OF MATHEMATICS AND SCIENCE
UNIVERSITAS NEGERI SURABAYA

TABLE OF CONTENT

A. SEMESTER LEARNING ACTIYITY PLAN

A.1. COURSE IDENTITY

Module Name	Quantum Chemistry
Module level	Bachelor
Abbreviation, if applicable	
Sub-heading, if applicable	-
Course included in the module, if applicable	-
Semester/term	2nd/First Year
Module coordinator(s)	Prof. Dr. Suyono, M.Pd.
Lecturer(s)	Dr. IGM Sanjaya, M.Si., Samik, S.Si., M.Si., and Findiyani E. Asih, S.Pd., M.Pd.
Language	Indonesian
Classification within the curriculum	Compulsory Course
Teaching format/class hours per week during the semester:	3 hours lecturers (50 min per hours)
Workload:	1 CU for bachelor degree equals to 3 workhours per week or 170 minutes (50' face to face learning, 60' structured learning, and 60' independent learning). In one semester, courses are conducted in 14 weeks (excluding mid and end-term exam). Thus, 1 CU equals to 39.67 workhours per semester. One CU equals to 1.587 ECTS.
Credit points:	3 x 1.587 = 4,761 ECTS
Prerequisites course(s):	Basic Chemistry I
Targeted learning outcomes:	1. Students can take advantage of digital transformation and various other learning resources to support their understanding of quantum chemistry. 2. Students can master the concepts and basic principles of quantum chemistry which are appropriate for the structure, bonds, and characteristics of various materials in physical chemistry. 3. Students are able to make decisions in formulating solutions to quantum chemical problems related to atomic structure, chemical bonds, molecular structure,

	molecular symmetry, spectroscopy and molecular interactions. 4. Students have good morals, ethics and personality in completing quantum chemistry assignments independently or in groups and are responsible for communicating the results. 5. Students have Ability to integrate the concept of technopreneurship in quantum chemistry
Content:	1. Basic Concepts and Principles of Quantum Chemistry. 2. The application of quantum chemistry to translational, vibration and rotation motion 3. The application of quantum chemistry to the structure of the hydrogen atom and the atom with many electrons 4. Chemical bond theory (Valence bond theory and molecular orbital theory) 5. Molecular symmetry 6. Molecular spectroscopy 7. Molecular interactions
Study / exam achievements:	Students are considered to be competent and pass if at least get 55 Final score is calculated as follows: 20% participation + 30% assignment + 20% middle exam (UTS) & 30% final exam (UAS) Table index of graduation • A = 4 (85 ≤-≥ 100) • A- = 3,75 (80 ≤-< 85) • B+ = 3,5 (75 ≤- < 80) • B = 3 (70 ≤-< 75) • B- = 2,75 (65 ≤-<75) • C+ = 2,5 (60 ≤-<65) • C = 2 (55 ≤-<60) • D = 1 (40 ≤-<55) • E = 0 (0 ≤-<40)
Media:	Computer, LCD, White board, internet
Learning Methods	Individuals assignment, group assignment, discussion, and presentation
Literature:	1. Atkins, P., Paula, J.d., and Keeler, J. 2018. Atkin's Physical Chemistry, 11th edition. New York: Oxford University Press. 2. Levine, Ira N. 2014. Quantum chemistry, 7th edition. New York: Pearson Education, Inc 3. Mortimer, R.G. 2008, Physical Chemistry, 3th edition, London: Elsevier Inc.
Note	

A.2. COURSE TOPIC

This course topic are quantum chemistry and its application of atomic structure, chemical bonds, molecular structure, properties of matter, molecular symmetry, spectroscopy and molecular interactions. This course is presented in theory, practice, and simple engineering through literacy, discussion, and assignments.

A.3. COURSE PROGRAM

UNESA	**UNIVERSITAS NEGERI SURABAYA** **FACULTY OF MATHEMATICS AND NATURAL SCIENCE** **UNDERGRADUATE PROGRAMME OF CHEMISTRY**	**Document Code**

SEMESTER LEARNING ACTIYITY PLAN

COURSE	**CODE**	**Course Group**	**Credit Unit**		**Semester**	**Date**
Quantum Chemistry	3074213020	Compulsory	**3**	**SCU**	2	6 January 2020

AUTHORIZATION CHEMISTRY	**Compiler**	**Coordinator**	**Head of Study Program**
		Prof. Dr. Suyono, M.Pd.	**Dr. Amaria, M.Si.**

Learning Outcomes		
	Program Learning Outcomes (PLO)	
	PLO1 (KNO-1)	Able to master the concepts of structure, dynamics and energy, as well as the basic principles of separation, analysis, synthesis, and characterization of micromolecular compounds and their applications
	PLO8 (SOC-2)	Able to adapt to various developments in chemistry, continue to develop and learn throughout long-life education, both formal and nonformal
	Course Learning Outcomes (CLO)	
	CLO1	Students can take advantage of digital transformation and various other learning resources to support their understanding of quantum chemistry.
	CLO2	Students can master the concepts and basic principles of quantum chemistry which are appropriate for the structure, bonds, and characteristics of various materials in physical chemistry.
	CLO3	Students are able to make decisions in formulating solutions to quantum chemical problems related to atomic structure, chemical bonds, molecular structure, molecular symmetry, spectroscopy and molecular interactions.
	CLO4	Students have good morals, ethics and personality in completing quantum chemistry assignments independently or in groups and are responsible for communicating the results.
	CLO4	Students have Ability to integrate the concept of technopreneurship in quantum chemistry

	Sub CLO	
	Sub-CLO1	Students are able to master the achievement targets of quantum chemistry course
	Sub-CLO2	Students are able to understand the basic principles of quantum chemistry
	Sub-CLO3	Students are able to apply quantum chemistry on translational motion
	Sub-CLO4	Students are able to apply quantum chemistry on vibrational motion
	Sub-CLO5	Students are able to apply quantum chemistry on rotational motion
	Sub-CLO6	Students are able to determine the structure and spectra of hydrogen atoms
	Sub-CLO7	Students are able to determine the structure and spectra of complex atoms
	Sub-CLO9	Students are able to understand valence bond theory or VBT
	Sub-CLO10	Students are able to understand MOT for diatomic molecules
	Sub-CLO11	Students are able to understand MOT for polyatomic molecules
	Sub-CLO12	Students are able to understand the basic principles of molecular symmetry
	Sub-CLO13	Students are able to apply symmetry and group symmetry of a molecule
	Sub-CLO14	Students are able to understand the basic principles of molecular spectroscopy
	Sub-CLO15	Students are able to understand molecules related interactions which with the electrical and interfacial properties of a matter
Brief Description of the Course	This course studies quantum chemistry and its application of atomic structure, chemical bonds, molecular structure, properties of matter, molecular symmetry, spectroscopy and molecular interactions. This course is presented in theory, practice, and simple engineering through literacy, discussion, and assignments.	
Study Materials: Learning Materials	1. Basic Concepts and Principles of Quantum Chemistry. 2. The application of quantum chemistry to translational, vibration and rotation motion 3. The application of quantum chemistry to the structure of the hydrogen atom and the atom with many electrons 4. Chemical bond theory (Valence bond theory and molecular orbital theory) 5. Molecular symmetry 6. Molecular spectroscopy 7. Molecular interactions	
Reference	**Main :**	
	1. Atkins, P., Paula, J.d., and Keeler, J. 2018. Atkin's Physical Chemistry, 11th edition. New York: Oxford University Press. 2. Levine, Ira N. 2014. Quantum chemistry, 7th edition. New York: Pearson Education, Inc	
	Additional :	

	1. Mortimer, R.G. 2008, Physical Chemistry, 3th edition, London: Elsevier Inc.						
Lecturer	Dr. IGM Sanjaya, M.Si., Samik, S.Si., M.Si., and Findiyani E. Asih, S.Pd., M.Pd.						
Prerequisite courses	Basic Chemistry I						
Meeting	**The final ability of each activity**	**Assessment**		**Learning Forms, Learning Methods, Student Assignment**		**Reference**	**Rating Weight (%)**
		Indicator	**Criteria & Form**	***Offline***	***online***		
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
1	Mastering the achievement targets of quantum chemistry course	Mentioning the achievements of quantum chemistry course	Introduction and contract of quantum chemistry Essay Test		Presentation and discussion	RPS KF I	0
2	Understanding the basic principles of quantum chemistry	Distinguishing Schrodinger equations based on dependent and independent time	The basic principles of Quantum Chemistry Essay Test		Presentation and discussion	Ref. 1 hal 249 - 287 Ref. 2	10
3	Applying quantum chemistry on translational motion	Defining function waves of particle, energy and density of particles in squares of 1, 2, and 3 dimensions	Application of translational motion Essay Test		Presentation and discussion	Ref. 1 hal 288 - 300 Ref. 2	5
4	Applying quantum chemistry on vibrational motion	Determining the wave function of the particle and the energy levels of the vibrational motion	Application of vibrational motion Essay Test		Presentation and discussion	Ref. 1 hal 300 - 306 Ref. 2	5
5	Applying quantum chemistry on rotational motion	Determining the wave function of the particle	Application of rotational motion		Presentation and discussion	Ref. 1 hal 306 - 323	5

		and the rotational energy levels	Essay Test			Ref. 2	
6	Determining the structure and spectra of hydrogen atoms	Determining the structure, shape and energy of atomic orbitals, and hydrogen spectra	structure and spectra of Hydrogen atom Essay Test		Presentation and discussion	Ref I hal 324 – 338 Ref. 2	10
7	Determining the structure and spectra of complex atoms	Analyzing orbital approximation and term symbol	structure and spectra of Complex atom Essay Test		Presentation and discussion	Ref I hal 338 – 370	10
8	Mid-Term Exam						
9	Understanding valence bond theory or VBT	Explaining VBT of diatomic and polyatomic molecules	Valence bond theory Essay Test		Presentation and discussion	Ref I hal 371 - 377	5
10	Understanding MOT for diatomic molecules	Writing the electron configuration of a diatomic molecule	MOT for diatomic molecules Essay Test		Presentation and discussion	Ref I hal 378 – 395	5
11	Understanding MOT for polyatomic molecules	Describing the electronic structure of a polyatomic molecules	MOT for polyatomic molecules Essay Test		Presentation and discussion	Ref I hal 395 – 401	10
12	Understanding the basic principles of molecular symmetry	Defining elements and operations on molecular symmetry	The basic principles of molecular symmetry Essay Test		Presentation and discussion	Ref I hal 409 – 426	10

13	Applying symmetry and group symmetry of a molecule	Analyzing the group symmetry of a molecule	Symmetry and group symmetry of a molecule Essay Test		Presentation and discussion	Ref I hal 427 – 444	10
14	Understanding the basic principles of molecular spectroscopy	Distinguishing between translational, vibrational and rotational spectra	The basic principles of molecular spectroscopy Essay Test		Presentation and discussion	Ref I hal 445 – 563	5
15	Understanding molecules related interactions which with the electrical and interfacial properties of a matter	Analyzing the molecular interactions which produce the electrical and interfacial properties of a material	The molecular interactions which produce the electrical and interfacial properties of a material Essay Test		Presentation and discussion	Ref I hal 340 – 370	10
16	**Final Exams**						**100**

A.4. MAPPING OF LEARNING OUTCOMES – COURSE OUTCOMES

A.4.1. The Expected Program Learning Outcomes (PLO) of Undergraduate Program of Chemistry (UPC)

ASPECTS	PLO	CODE
KNOWLEDGE	1. Able to master the concepts of structure, dynamics and energy, as well as the basic principles of separation, analysis, synthesis, and characterization of micromolecular compounds and their applications	**KNO-1**
	2. Able to master the basic principles and knowledge of how to operationalize instruments for the analysis and characterization of compounds, as well as utilizing ICT for modeling more specific molecules	**KNO-2**
SKIL	3. Able to master the principles of Occupational Health and Safety, manage laboratories and use their equipment, and operate instrumental of chemistry	**SKI-1**
	4. Able to design an activity to solve problems by implementing capabilities in the field of chemistry that refers to ecopreunership	**SKI-2**
COMPETENCIES	5. Able to apply logical, critical, systematic and innovative thinking in the context of the development or implementation of science and technology by observe and applying the value of humanities in accordance with the field of chemistry in solving problems	**COM-1**
	6. Able to master the basics of the scientific method, designing and conducting research, compiling scientific reports and communicating them both verbally and in writing by utilizing information and communication technology	**COM-2**
ATTITUDE AND SOCIAL	7. Able to build teamwork and have entrepreneurial skills that are environmental perspective, and make the right, honest and responsible decisions in solving problems of chemistry and have social sensitivity as a obligation of citizens and religious communities	**SOC-1**
	8. Able to adapt to various developments in chemistry, continue to develop and learn throughout long-life education, both formal and nonformal	**SOC-2**

A.4.2. The Education Program Objectives (PEOs) of Quantum Chemistry

A4.3. Mapping of Program Learning Outcomes (PLO) – Education Program Objectives (PEOs)

	PLO 1 (KNO-1)	PLO 8 (SOC-2)
PEO 1	S	NS
PEO 3	S	S

B. COURSE ASSESSMENT

B.1. Assessment Rubric

Cognitive Criteria

1. The ability to give answers correctly
2. The ability to provide argumentation according to theory
3. The ability to provide systematic explanations
4. The ability to solve problems comprehensively

B.2. Assessment System

Final Assessment Course **without practicum**

Practicum : 0%
Group/Individuals Assignment : 30%
Midterm examination : 30%
Final examination : 40%

Distribution of the weight of the ability of the test item

	PLO 1 (KNO-1)	PLO 8 (SOC-2)	Total
Practicum	0%	0%	0%
Group/Individuals Assignment	60%	40%	100%
Midterm examination	80%	20%	100%
Final examination	70%	30%	100%

Success Criteria of Program Learning Outcomes (PLO)

Excellent	≥ 80
Good	≥ 70
Satisfy	≥ 55
Failed	< 55

Final index for undergraduate program defined as follow:

Final Index	Range
A	4 (85 ≤-≥ 100)
A^-	3,75 (80 ≤-< 85)
B+	3,5 (75 ≤- < 80)
B	3 (70 ≤-< 75)
B-	2,75 (65 ≤-<70)
C+	2,5 (60 ≤-<65)
C	2 (55 ≤-<60)
D	1 (40 ≤-<55)
E	0 (0 ≤-<40)

C. COURSE DEVELOPMENT

C.1. Academic Year 2019/2020

Parameter	∑ of person	Percentage
Number or students taking this subject	67	100%
Number of students who pass at first attempt (>B^-)	64	95.6%
Number of students who pass at first attempt (C ≥ - ≤ B^-)	2	2.9%
Number of failed students after remedial (D & E)	1	1.5%

C.2. Problems Analysis

In 2019/2020 academic year in the quantum chemistry course, there were 98.5 % of students who had passed the examination at the first attempt. At the end of the semester examination, there is remedial for one student. There is one student who did not graduate because the student did not take the final exam. There are 66 students who graduated in above standard >70, but 2 students in below standard, namely 55≥x<70. So, it concluded that the learning strategy/methods still need to be improved for achieving higher results in the future. The average final score in 2019/2020 is lower than before, due to students have different characteristics, namely they difficult to cooperate with their group and not serious when doing the task, therefore the have lack of average score.

C.3. Solutive Strategy

New teaching and learning methods should be developed for the next academic years, consisting of:

1. Redesigning the course material (PPT slides, course contents, etc.) to become more interesting and interactive to stimulate student's interest in this course.
2. Giving "lecture by online" to stimulate our students to learn about the next lecture topics.
3. Enhance the cooperative skills of students with exchange the methods and models of learning

D. APPENDICES

D.1. DOCUMENT OF COURSE ACTIVITY

D.1.1. Lecture's journal and student's attendance

6/19/2021 SIAKADU: Cetak Jurnal Perkuliahan

KEMENTERIAN RISET, TEKNOLOGI, DAN PENDIDIKAN TINGGI
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F: +6231-8293484
laman: unesa.ac.id
email : bakpk@unesa.ac.id

Aktivitas Perkuliahan

Nama Matakuliah : Kimia Fisika I: Kimia Kuantum **Dosen** : I GUSTI MADE SANJAYA (196512041993021001)
Kelas : 2019A SAMIK (198308062012121001)
Jadwal & Ruang : C06.04.01-A (13.00 - 15.30) R.

No.	Tanggal	Pertemuan	Topik	Peserta	Status	Dosen	Kesesuaian	Saran
1	04-02-2020	Pertemuan ke 1	Pengantar dan kontrak perkuliahan kimia kuantum	34	Terjadwal	I Gusti Made Sanjaya	Sesuai	
2	11-02-2020	Pertemuan ke 2	Dasar-dasar Kimia Kuantum	34	Terjadwal	I Gusti Made Sanjaya	Sesuai	
3	18-02-2020	Pertemuan ke 3	Kuantum gerak translasi.	34	Terjadwal	I Gusti Made Sanjaya	Sesuai	
4	25-02-2020	Pertemuan ke 4	Kuantum gerak vibrasi.	34	Terjadwal	I Gusti Made Sanjaya	Sesuai	
5	03-03-2020	Pertemuan ke 5	Kuantum gerak rotasi.	34	Terjadwal	I Gusti Made Sanjaya	Sesuai	
6	10-03-2020	Pertemuan ke 6	struktur dan spektra atom hidrogen	34	Terjadwal	I Gusti Made Sanjaya	Sesuai	
7	17-03-2020	Pertemuan ke 7	Struktur dan spektra atom kompleks	34	Terjadwal	I Gusti Made Sanjaya	Sesuai	
8	24-03-2020	Pertemuan ke 8	UTS	34	Terjadwal	I Gusti Made Sanjaya		
9	31-03-2020	Pertemuan ke 9	VBT	34	Terjadwal	I Gusti Made Sanjaya		
10	07-04-2020	Pertemuan ke 10	MOT molekul diatomik	34	Terjadwal	I Gusti Made Sanjaya		
11	14-04-2020	Pertemuan ke 11	MOT molekul poliatomik	34	Terjadwal	I Gusti Made Sanjaya		
12	21-04-2020	Pertemuan ke 12	Unsur dan operasi simetri	34	Terjadwal	I Gusti Made Sanjaya		

13	28-04-2020	Pertemuan ke 13	Penerapan simetri molekul	34	Terjadwal	I Gusti Made Sanjaya		
14	05-05-2020	Pertemuan ke 14	Spektroskopi molekul	34	Terjadwal	I Gusti Made Sanjaya		
15	12-05-2020	Pertemuan ke 15	Interaksi molekul	34	Terjadwal	I Gusti Made Sanjaya		

KEMENTERIAN RISET, TEKNOLOGI, DAN PENDIDIKAN TINGGI
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laman: unesa.ac.id
email : bakpk@unesa.ac.id

Aktivitas Perkuliahan

Nama Matakuliah : Kimia Fisika I: Kimia Kuantum
Kelas : 2019B
Jadwal & Ruang : C06.04.01-B (13.00 - 15.30) R.

Dosen : I GUSTI MADE SANJAYA (196512041993021001)
SAMIK (198308062012121001)

No.	Tanggal	Pertemuan	Topik	Peserta	Status	Dosen	Kesesuaian	Saran
1	04-02-2020	Pertemuan ke 1	Pengantar dan kontrak perkuliahan kimia kuantum	32	Terjadwal	I Gusti Made Sanjaya	Sesuai	
2	11-02-2020	Pertemuan ke 2	Dasar-dasar Kimia Kuantum	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
3	18-02-2020	Pertemuan ke 3	Kuantum gerak translasi.	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
4	25-02-2020	Pertemuan ke 4	Kuantum gerak vibrasi.	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
5	03-03-2020	Pertemuan ke 5	Kuantum gerak rotasi.	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
6	10-03-2020	Pertemuan ke 6	struktur dan spektra atom hidrogen	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
7	17-03-2020	Pertemuan ke 7	Struktur dan spektra atom kompleks	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
8	24-03-2020	Pertemuan ke 8	UTS	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
9	31-03-2020	Pertemuan ke 9	VBT	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
10	07-04-2020	Pertemuan ke 10	MOT molekul diatomik	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
11	14-04-2020	Pertemuan ke 11	MOT molekul poliatomik	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
12	21-04-2020	Pertemuan ke 12	Unsur dan operasi simetri	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	

13	**28-04-2020**	Pertemuan ke 13	Penerapan simetri molekul	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
14	**05-05-2020**	Pertemuan ke 14	Spektroskopi molekul	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	
15	**12-05-2020**	Pertemuan ke 15	Interaksi molekul	33	Terjadwal	I Gusti Made Sanjaya	Sesuai	

D.1.2. Sample of statement of examination official report

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS NEGERI SURABAYA
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
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Telepon: +6231- 8298761
Faksimile : +6231- 8298761
e-mail kimia@unesa.ac.i

BERITA ACARA UJIAN AKHIR SEMESTER

Pada hari ini **Kamis** tanggal **14 Mei 2020** telah dilaksanakan Ujian Akhir Semester (UAS) daring Semester Genap 2019 – 2020 via *Google Classroom*. Ujian dimulai pukul **12.00** dan di akhiri pukul **13.40** selama **100** menit.

Program Studi : **Kimia**
Mata Kuliah yang diujikan : **Kimia Fisika I**
Kelas : **KA 2019**
Dosen Pengampu : **Tim**

Jumlah Peserta : **34** orang
Jumlah Hadir : **34** orang
Jumlah Tidak Hadir : 0 orang, yaitu

1. -	4. -	7. -
2. -	5. -	8. -
3. -	6. -	9. -

Kejadian selama ujian berlangsung.
.....
.....

Nama Pengawas :	1. -	Tanda Tangan :	1. -
	2. -		2. -
	3. -		3. -
	4. -		4.-

Demikian Berita Acara Ujian Akhir Semester

Ditetapkan di : Surabaya
Pada tanggal : 14 Mei 2020
Panitia Ujian Akhir Semester Genap 2019/2020

Dr. Maria Monica S. B. W, M.Si
NIP. 196405031992022001

Tembusan :
Berita acara ini dibuat rangkap dua untuk jurusan
1 lembar dan fakultas 1 lebar

D.2. SAMPLE OF STUDENT WORK

D.2.1. Sample of Test Paper

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
UNIVERSITAS NEGERI SURABAYA
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
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SOAL UJIAN AKHIR SEMESTER GENAP 2019/2020

Mata Ujian	: Kimia Fisika I: Kimia Kuantum
Jurusan/Fakultas	: Kimia / MIPA
Program/Angkatan	: Kimia/Kimia/2019
Hari/Tanggal mulai	: Kamis, 14 Mei 2020
Waktu	: Jam III (12.00-13.40, 100 menit)
Dosen	: Tim
Sifat Ujian	: Open Book/Source

Jawablah Soal-soal berikut dalam dokumen Ms-Word!

1. Analisis pada spesi kimia berikut ini yang mana menghasilkan ikatan kimia, yang mana hanya menghasilkan gaya ikat fisik, dan yang mana tidak menghasilkan ikatan yaitu: H_2^{2+}, H_2^{+}, H_2^{-}, He_2^{4+}, He_2^{+}, He_2, He_2^{-}, Be_2^{+}, Be_2, dan Be_2^{-}. (Nilai 20)
2. Menurut teori VBT ikatan terjadi melalui tumpangsuh orbital valensi yang memungkinkan terjadinya pembentukan orbital hibrida. Bila ini melibatkan 1 orbital s dan 2 orbital p, jelaskan:
   a. Jenis orbital hibrida apakah yang terbentuk serta sebutkan berapa jumlahnya, (Nilai 10)
   b. Jenis ikatan apa saja yang terjadi, berapa jumlahnya masing-masing dan terjadi melalui tumpangsuh yang seperti apa. (Nilai 10)
   c. Apakah pembentukan orbital hybrid tersebut selalu didahului dengan terjadinya promosi elektron dan mengapa hal itu terjadi? (Nilai 10)
3. Bila suatu orbital suatu molekul $\psi_{\pm}$ dibentuk dari orbital atom A yang disimbolkan dengan ϕ_A dan orbital atom B yang disimbolkan dengan ϕ_B, maka
   a. tuliskan simbol fungsi gelombang dari masing-masing orbital molekul yang terbentuk dan lengkapi dengan gambar dari masing-masing bentuk fungsi gelombang tersebut. (Nilai 10)
   b. tuliskan simbol kerapatan elektron yang dihasilkan dari masing-masing orbital molekul yang terbentuk dan lengkapi dengan gambar bentuk kerapatannya. (Nilai 10)
   c. Berdasarkan hasil kerapatan elektron menurut poin 3.b., jelaskan bagaimana syarat agar dapat membedakan antara pembentukan ikatan kovalen non-polar, ikatan kovalen polar, dan ikatan ion. (Nilai 10)

4. Perhatikan molekul-molekul CH4, CH3Cl, CH2ClF, dan CHIClF.
   a. Analisis apakah keempat molekul tersebut memiliki elemen simetri dan operasi simetri yang sama? (Lengkapi jawaban Anda dengan data elemen dan operasi simetri dari masing-masing molekul tersebut) (Nilai 10)
   b. Analisis apakah keempat molekul memiliki group simetri yang sama? (lengkapi jawaban Anda dengan identifikasi group simetri masing-masing molekul tersebut) (Nilai 10)

========== Selamat Bekerja ==========

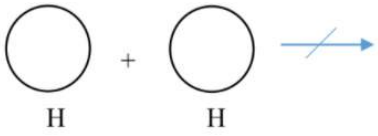
D.2.2. Sample of Student's Work

KIMIA FISIKA I: KIMIA KUANTUM

Atha Aurelia Alora Asis / 19030234004 / KA2019

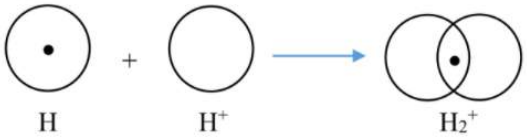
1. Analisis Ikatan, terjadi saat tumpang tindih, ada pemakaian e^- bersamaan

- H_2^{2+}



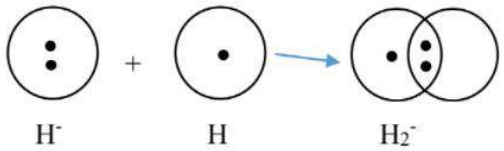
Tidak terjadi ikatan kimia, hanya terjadi ikatan fisik

- H_2^+



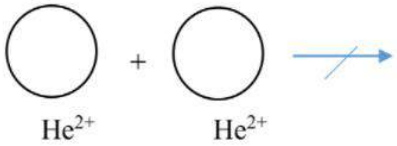
Terjadi ikatan kimia, terjadi ikatan fisik

- H_2^-



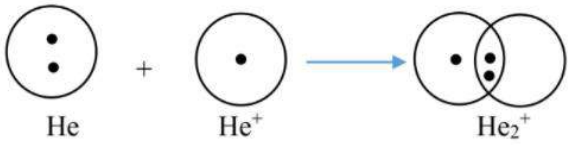
Terjadi ikatan kimia, terjadi ikatan fisik

- He_2^{4+}



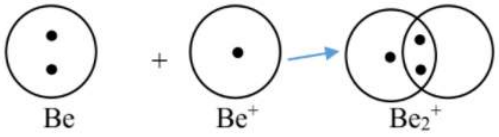
Tidak terjadi ikatan kimia, terjadi ikatan fisik

- He_2^+



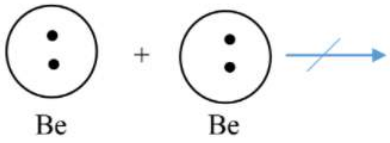
Terjadi ikatan kimia, terjadi ikatan fisik

- Be_2^+



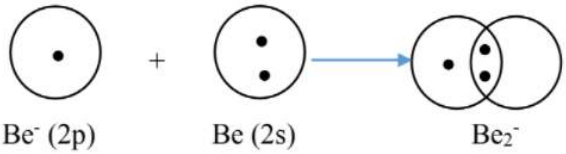
Terjadi ikatan kimia, terjadi ikatan fisik

- Be_2



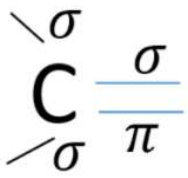
Tidak terjadi ikatan kimia, terjadi ikatan fisik

- Be_2^-



Tidak terjadi ikatan kimia, terjadi ikatan fisik

2. Hibrida pada 1 orbital s dan 2 orbital p
   a. 1 orbital s dan 2 orbital p dapat menghasilkan jenis orbital hibrida sp^2. Jumlah dari orbital hibrid tersebut $3sp^2$ dan memiliki 1 p yang unhibrid.
   b. Pada pembentukan orbital hibrida yang melibatkan 1 orbital s dan 2 orbital p dengan memiliki orbital hibrid sp^2 maka akan menghasilkan jenis ikatan σ dan π. Pada orbital hibrid sp^2 akan memiliki 2 ikatan tunggal yang akan mengikat 2 unsur lain dan juga memiliki 1 ikatan ganda yang mengikat unsur lainnya.



Pada ikatan tunggal terbentuk ikatan σ dengan tumpangsuh $sp^2 - s$

Pada ikatan rangkap terbentuk ikatan σ dan π, dengan ikatan sigma dengan tumpangsuh $sp^2 - sp^2$. Dan ikatan π dengan tumpangsuh p – p .

c. Orbital hybrid ini selalu didahului dengan terjadinya promosi elektron dari keadaan dasar menjadi terhibridisasi. Jika tidak dilakukan promosi, maka tidak akan memiliki orbital yang dapat mengikat 3 unsur dengan 2 ikatan tunggal dan 1 ikatan rangkap. Jika dilakukan promosi dan terjadi hibridisasi, maka dapat memiliki orbital yang cukup untuk dapat berikatan dengan 3 unsur lainnya. Pada keadaan dasar memiliki konfigurasi $2s^2$ dan $2p^2$, pada konfigurasi tersebut hanya memiliki 2 orbital yang dapat menerima elektron dari unsur lain dan dengan keadaan terhibridisasi konfigurasi menjadi $2s^1\, 2p_x^1\, 2p_y^1 2p_z^1$ dari konfigurasi tersebut tampak bahwa dapat berikatan dengan lebih dari 2 unsur.

3. Bila suatu orbital suatu molekul ψ± dibentuk dari orbital atom A yang disimbolkan dengan φA dan orbital atom B yang disimbolkan dengan φB, maka,

a.

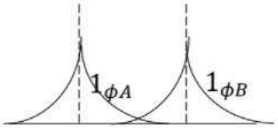
$\psi_1 = \phi A + \phi B$ $\qquad$ $\psi_2 = \phi A - \phi B$

Memiliki node (daerah tanpa electron)

b.

$\psi_1{}^2 = N^2((\phi(A) + \phi(B))^2$

Gambar kerapatan :



Interferensi konstruksi di daerah antar inti

Rapatan peluang elektron

$\psi^2 = N^2((\psi_{1s}(\phi A) - (\phi B))^2$

c. Ikatan kovalen kutub terdiri atas dua elektron pada orbital yang terbentuk

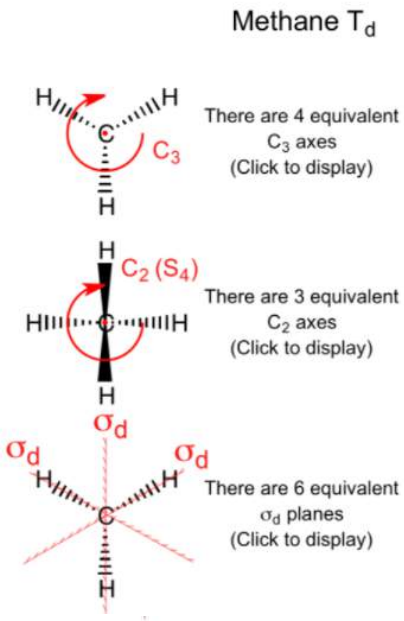
$$\psi = c_A\phi(A) + c_B\phi(B)$$

Dengan koefisien yang tidak sama. Perbandingan orbital atom $\psi(A)$ di dalam ikatan adalah c_A^2 dan pada perbandingan $\psi(B)$ adalah c_B^2.

- Ikatan nonpolar (diatomik homonuklir) : $c_A^2 = c_B^2$
- Ikatan ionik murni : mempunyai satu koefisien nol (A^+B^- akan mempunyai $c_A = 0$ dan $c_B = 1$)
- Ikatan polar : $|C_A|^2 > 0$ atau $|C_B|^2 > 1$

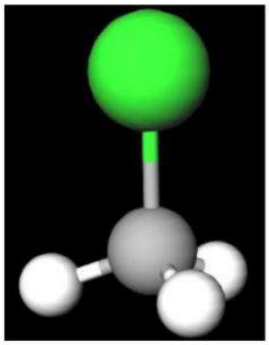
4. Molekul CH_4, CH_3Cl, CH_2ClF, dan CHIClF

a. CH_4



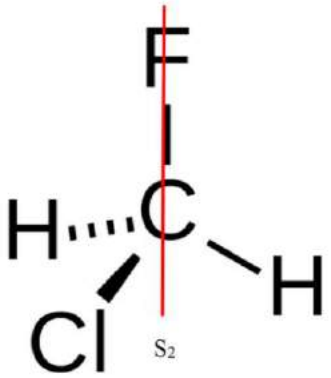
- ✓ Identitas (E)
- ✓ Rotasi $8C_3$ (sumbu utama), $4C_2$
- ✓ Rotasi tak wajar $6S_4$
- ✓ Refleksi $6\sigma_d$

CH_3Cl



- ✓ Identitas (E)
- ✓ Rotasi C_2
- ✓ Refleksi $3\sigma_v$

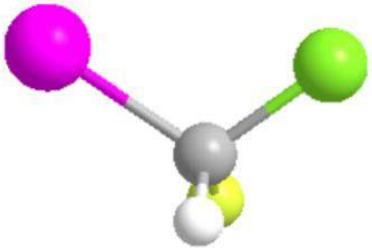
CH_2ClF



- ✓ Identitas (E)
- ✓ Rotasi tak wajar S_2

CHIClF

- ✓ Identitas (E)



Dari keempat molekul diatas, tidak semuanya memiliki elemen dan operasi simetri yang sama.

b. Identifikasi grup simetri

- CH_4

  x linier → x 2 atau lebih C_5 → x 2 atau lebih C_4 → ada $4C_3$ → ada σ → x inversi → Td

- CH_3Cl

  x linier → x 2 atau lebih C_5 → x 2 atau lebih C_4 → x $4C_3$ → ada C_n, n>1 → x C_2 tegak lurus Cn → x σ_h → ada $n\sigma_v$ → $C_{nv} = C_{3v}$

- CH_2ClF

  x linier → x 2 atau lebih C_5 → x 2 atau lebih C_4 → x $4C_3$ → x C_n, n>1 → x σ → x inversi → C_1

- CHIClF

  x linier → x 2 atau lebih C_5 → x 2 atau lebih C_4 → x $4C_3$ → x C_n, n>1 → x σ → x inversi → C_1

D.3. RECAPITULATION OF ASSESSMENT

D.3.1. Validate Test Item

The end-of-semester evaluation questions consist of four items in the form of essay questions analyzed content through experts in the appropriate field of Quantum Chemistry. Essay questions are validated with expert judgment in the course team members. The analysis was conducted by taking into account several aspects, namely the suitability of the questions with the course outcome, language, content and construct.

D.3.2 Evaluation Results of Quantum Chemistry

PROGRAM STUDI S1 Kimia

DAFTAR NILAI MAHASISWA

Mata Kuliah : Kimia Fisika I: Kimia Kuantum

Kelas : 2019A

Tahun Ajaran : 2019/2020 Genap

Original data :

Keterangan :

1. Komponen nilai yang diisi hanya : Part,Tugas,UTS dan UAS
2. Nilai UAS mahasiswa dengan kehadiran dibawah 73.3% (kolom dg warna merah) tidak akan disimpan
3. Jangan merubah apapun di dokumen ini kecuali pada point nomer satu di atas.
4. PPTI / BAAK tidak menerima file nilai untuk diupload. Proses upload nilai dilakukan oleh dosen pengampu yang bersangkutan.

No	NIM	Nama Mahasiswa	Angkatan	Kehadiran	Part	Tugas	UTS	UAS	NA	Huruf	Pakai
1	19030234002	SINTA ANJAS CAHYANI	2019	100%	85	85	75	76	80.3	A-	1
2	19030234004	ATHA AURELIA ALORA ASIS	2019	100%	85	85	75	77	80.6	A-	1
3	19030234005	SYANANDA ZAHRA FADILA	2019	100%	85	85	75	75	80	A-	1
4	19030234006	ELVIRA RATNA AISA	2019	100%	85	85	75	83	82.4	A-	1
5	19030234007	GATI NURHIDAYAH	2019	100%	85	85	75	76	80.3	A-	1
6	19030234008	INDIRA DWI AULIA	2019	100%	85	85	75	78	80.9	A-	1
7	19030234009	EKA FARADILA OKTANINGTIAS	2019	100%	85	85	75	79	81.2	A-	1
8	19030234011	NUNIK TRI RAHAYU	2019	100%	85	85	75	76	80.3	A-	1
9	19030234012	ELYS SAFITRI	2019	100%	85	85	75	78	80.9	A-	1
10	19030234013	NABILA SYAFA'ATI	2019	100%	85	85	75	76	80.3	A-	1
11	19030234014	GLADYS JAVANI	2019	100%	85	85	75	76	80.3	A-	1
12	19030234016	AHMAD RUDI SETIAWAN	2019	100%	85	85	75	76	80.3	A-	1
13	19030234019	SHABIHISMA AULIYA NURDIN	2019	100%	80	75	75	0	53.5	D	1
14	19030234020	FIFIN SETIANI	2019	100%	85	85	75	75	80	A-	1
15	19030234021	RAHMA NURISNAINI	2019	100%	85	85	75	76	80.3	A-	1
16	19030234023	PUTRI AISYAH NURHIDAYAH	2019	100%	85	85	75	76	80.3	A-	1
17	19030234024	PUTRI AMALIA PUSPITASARI	2019	100%	85	85	75	76	80.3	A-	1
18	19030234026	AWIDDAH ZUHROH NABILA	2019	100%	85	85	75	76	80.3	A-	1
19	19030234027	SILFIA INDAH ACHRIFA	2019	100%	85	85	75	76	80.3	A-	1
20	19030234028	ARDIKA PRASETYA AJI	2019	100%	85	85	75	76	80.3	A-	1
21	19030234030	NUR ANISA ROSYIIDAH	2019	100%	85	85	75	76	80.3	A-	1
22	19030234032	INDRI WASA ESTININGTYAS	2019	100%	85	85	75	76	80.3	A-	1
23	19030234034	WIDI SALSABILA	2019	100%	80	80	75	76	77.8	B+	1
24	19030234036	LUKLUKUL FITRIYAH	2019	100%	85	85	75	77	80.6	A-	1
25	19030234038	ARFINDA MULYA DEWI	2019	100%	85	85	75	81	81.8	A-	1
26	19030234040	AHMAD MISBAKHUS SURURI	2019	100%	85	85	75	78	80.9	A-	1
27	19030234044	MUKHLASH IMADUDDIN	2019	100%	85	85	75	75	80	A-	1
28	19030234045	M. IQBAL AL GHIFARI	2019	100%	85	85	75	76	80.3	A-	1
29	19030234047	QOMARIYAH AGUSTIN	2019	100%	85	85	75	76	80.3	A-	1
30	19030234057	FISTARA LESTI RAHMAFITRIA	2019	100%	85	85	75	76	80.3	A-	1
31	19030234059	HALIMATUN NAFISAH	2019	100%	0	70	75	76	58.8	C	1
32	19030234060	NUR HANDINI PRISMA KUSTANTI	2019	100%	85	85	75	76	80.3	A-	1
33	19030234062	VANI DWI HANI PUTRI	2019	100%	85	85	75	76	80.3	A-	1
34	19030234065	DHEA ANGGRAINI PUTRI	2019	100%	85	85	75	82	82.1	A-	1

PROGRAM STUDI S1 Kimia

DAFTAR NILAI MAHASISWA

Mata Kuliah : Kimia Fisika I: Kimia Kuantum

Kelas : 2019B

Tahun Ajaran : 2019/2020 Genap

Original data :

Keterangan :

1. Komponen nilai yang diisi hanya : Part,Tugas,UTS dan UAS
2. Nilai UAS mahasiswa dengan kehadiran dibawah 73.3% (kolom dg warna merah) tidak akan disimpan
3. Jangan merubah apapun di dokumen ini kecuali pada point nomer satu di atas.
4. PPTI / BAAK tidak menerima file nilai untuk diupload. Proses upload nilai dilakukan oleh dosen pengampu yang bersangkutan.

No	NIM	Nama Mahasiswa	Angkatan	Kehadiran	Part	Tugas	UTS	UAS	NA	Huruf	Pakai
1	19030234001	KARIZA ALYA AULIA FIRDAUS	2019	100%	85	85	75	78	80.9	A-	1
2	19030234003	ALVISYAH NAZAREND	2019	100%	85	85	75	80	81.5	A-	1
3	19030234010	MUFIDATUL ILMIAH	2019	100%	85	85	75	81	81.8	A-	1
4	19030234015	MAS IDATUL UMAH	2019	100%	85	85	75	82	82.1	A-	1
5	19030234017	MOHAMMAD NURUL MUSTOFA	2019	100%	85	85	75	79	81.2	A-	1
6	19030234022	SHEVY KARUNIA CAHYANINGTIAS	2019	100%	85	85	75	78	80.9	A-	1
7	19030234025	SAKURA PUTRI TANAKA	2019	100%	85	85	75	78	80.9	A-	1
8	19030234029	BEBY PUTRI RAHAYU	2019	100%	80	75	0	75	61	C+	1
9	19030234031	NADIAH ARMADANTI SALMA	2019	100%	85	85	75	76	80.3	A-	1
10	19030234033	RIKA SARI	2019	100%	85	85	75	75	80	A-	1
11	19030234037	SITI NOVITA SARI ULFA	2019	100%	85	85	75	77	80.6	A-	1
12	19030234039	KHARISMA NARESWARI WAHYANTO	2019	100%	85	85	75	82	82.1	A-	1
13	19030234041	SITI NUR KOMARIYAH	2019	100%	85	85	75	84	82.7	A-	1
14	19030234042	CINDHA PUSPA RISKYTAMA	2019	100%	85	85	75	80	81.5	A-	1
15	19030234043	RISTI WULANINGTYAS	2019	100%	85	85	75	83	82.4	A-	1
16	19030234046	NUR AZIZAH WANDA TRIYARUHANA	2019	100%	85	85	75	81	81.8	A-	1
17	19030234048	AVISSA AURYN WIJAYANTI	2019	100%	85	85	75	78	80.9	A-	1
18	19030234050	AHMAD JIHAD HIZBULLAH	2019	100%	85	85	75	83	82.4	A-	1
19	19030234051	RISKY AMALIA	2019	100%	85	85	75	79	81.2	A-	1
20	19030234052	NI NYOMAN TRIYANI DAMAYANTI	2019	100%	85	85	75	83	82.4	A-	1
21	19030234053	SITI ALIHATUS FATIMAH	2019	100%	85	85	75	77	80.6	A-	1
22	19030234054	BROWI NUGROHO	2019	100%	85	85	75	70	78.5	B+	1
23	19030234055	NUR ANISA PUNGKASARI	2019	100%	85	85	75	82	82.1	A-	1
24	19030234056	DZIKRA NASYAYA MAHFUDHAH	2019	100%	85	85	75	81	81.8	A-	1
25	19030234058	NIKE NUR FADILAH	2019	100%	85	85	75	76	80.3	A-	1
26	19030234061	NAFISATUZ ZAHRO	2019	100%	85	85	75	78	80.9	A-	1
27	19030234063	SHERLY WAHYU ADRIANI	2019	100%	85	85	75	82	82.1	A-	1
28	19030234064	FADLURACHMAN FAIZAL FACHRIRAKARSIE	2019	100%	85	85	75	75	80	A-	1
29	19030234066	M. FAJRUL FALAH	2019	100%	85	85	75	75	80	A-	1
30	19030234067	HANIDA FEBRIANTI DWI LESTARI	2019	100%	85	85	75	77	80.6	A-	1
31	19030234068	WIDYANA KURNIA	2019	93.33%	80	78	75	77	77.5	B+	1
32	19030234069	DEFI AYUNDA	2019	100%	85	85	75	79	81.2	A-	1
33	19030234070	NAFISATUS ZAKIYAH	2019	100%	85	85	75	80	81.5	A-	1

D.3.3 Percentage of PLO achievements of Quantum Chemistry at Academic Year 2019/2020

PLO ASSESSMENT

Lecture : Quantum Chemistry
Code : 4720103095
Department : Chemistry Department
Total of Student : 101

	PLO-1	PLO-2	PLO-3	PLO-4	PLO-5	PLO-6	PLO-7	PLO-8
EXELENCE	12%							36%
GOOD	85%							61%
SATISFY	0%							1%
FALSE	3%							2%
	100%	0%	0%	0%	0%	0%	0%	100%