VISAYAS STATE UNIVERSITY

DEPARTMENT OF PURE & APPLIED CHEMISTRY
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OUTCOMES-BASED EDUCATION (OBE) COURSE SYLLABUS

CHEM208
Chemical Thermodynamics

I. UNIVERSITY INFORMATION

1. Vision of the University

A globally competitive university for science, technology, and environmental conservation

2. Mission of the University

Development of a highly competitive human resource, cutting-edge scientific knowledge and innovative technologies for sustainable communities and environment.

3. VSU Quality Policy Statement

The Visayas State University (VSU), a globally competitive university of science and technology and environmental conservation, is created by law to develop highly competitive human resource, cutting- edge scientific knowledge and innovative technologies for sustainable communities and environment.

Towards this end, we, at the Visayas State University, commit to:

- Produce highly competent, quality and world-class manpower in science and technology, especially for agriculture, environmental management and industry who are proficient in communication skills, critical thinking and analytical abilities;
- Generate and disseminate relevant knowledge and technologies that lead to improved productivity, profitability and sustainability in agriculture, environment and industry; and
- Satisfy the needs and applicable requirements of the industry, the community and government sectors who are in need of quality graduates and technology ready for commercialization through the establishment, operation, maintenance and continual improvement of a Quality Management System (QMS) which is aligned with the requirements of ISO 9001:2015.

It shall be the policy of the university that the quality policies and procedures are communicated to and understood by all faculty, staff, students and other stakeholders and that the system be continually improved for its relevance and effectiveness.

EDGARDO E. TULIN
President
v0 07-16-2019

4. Quality Goals and Objectives of the Graduate School

Goal:

- Produce high quality manpower in agriculture and its allied fields through graduate education to serve the development needs of the region.

General Objective:

- To strive for excellence in graduate education for regional growth and rural development.

Specific Objectives:

- To offer graduate courses to teachers, researchers, extension workers, administrators and other professionals;
- To train and guide graduate students in conducting productive and independent research studies relevant to agriculture and its allied fields, environmental management and industry;
- To design and implement innovative strategies for the enhancement of managerial and leadership skills of professional and development workers; and
- To strengthen personal discipline and moral character of graduate students to better serve their clientele.

5. Quality Objectives of the Department of Pure and Applied Chemistry

- Produce highly qualified and skilled Chemists and Chemical technicians for the industry and academia;
- Generate relevant knowledge and technologies through basic and applied multi- and inter-disciplinary researches; and
- Achieve strong linkages and cooperation with domestic and international institutions and agencies involved in the pursuit of sustainable development.

II. PROGRAM INFORMATION

1. Name of the Program	Master of Education
2. CHED CMO Reference	CHED CMO. No. 53 s. 2007 & CMO No. 15, S. 2019
3. BOR Approval	BOR Resolution 10, S. 2007

4. Program Educational Objectives and Relationship to Institution Mission

Program Educational Objectives	Mission*		
	a	b	c
1. Update and enrich classroom teachers' content knowledge in a specific subject area;	√		√
2. Enhance and expand classroom teachers' pedagogical knowledge and skills for teaching a specific subject area; and	√	√	√
3. Improve the classroom teachers' efficacy in producing innovative and creative instructional programs or materials that will improve the teaching-learning process.	√	√	√

**a - development of a highly competitive human resource, b - cutting-edge scientific knowledge, c - innovative technologies for sustainable communities and environment*

III. COURSE INFORMATION

1. Course Code	CHEM208
2. Course Title	Chemical Thermodynamics
3. Pre-requisite	COP
4. Co-requisite	None
5. Credit	3 units
6. Semester Offered	First Semester
7. Number of hours	3 hours lecture
8. Course Description	Fundamental laws of gases and chemical thermodynamics

9. Program Outcomes (POs) in relation to the Program Educational Objectives (POEs)

	Program Outcomes (POs)	Program Educational Objectives		
		1	2	3
a	In-depth understanding of a complex and coherent body of knowledge and skills in an area of study in education, which may be applied in many types of school or other educational environments;	√	√	√
b	A higher order level of skill in the analysis, critical assessment, and application and communication of knowledge in the field;	√	√	√
c	An ability to apply knowledge and skills in the field to new situations in more creative and flexible ways, and to solve complex problems in the field in ways that involve rigorous thinking and independent work;	√	√	√
d	Understand, develop, and sustain arguments about and critically evaluate the current problems, principles, and concepts of the field of study; most of which should be at the forefront of developments in the discipline;	√	√	√
e	Apply this current knowledge in original ways to specific problems or contexts by undertaking research, a complex project, or some other form of advanced scholarship;	√	√	√
f	Demonstrate a comprehensive understanding of the methods of inquiry in their own research or advance scholarship, and how these methods are used to create and interpret knowledge in the field;	√	√	√
g	Creatively and systematically deal with complex issues within a field, make judgements, or decisions in the absence of complete data, and clearly communicate one's justification for such actions to specialist and non-specialist audiences;	√	√	√
h	Demonstrate initiative, self-direction and originality in dealing with problems in the field (e.g. develop innovative teacher approaches and resources; establish new teacher supervisory systems, etc.) particularly in the planning and execution of tasks in the field;	√	√	√
i	Continue to advance their knowledge and skills in the field using the established sources of advanced information in the field; and	√	√	√
j	Undertake more advanced and specialized training for developing existing skills, acquiring higher level and	√	√	√

	more specialized competencies in the formal higher education context.			

10. Course Outcomes (COs) and Relationship to Program Outcomes (POs)													
After completing this course, the student must be able to perform the following COs:	*Program Outcomes Code*												
	a	*b*	*c*	*d*	*e*	f	g	h	i	j	k	l	m
CO1: Assess the fundamental laws that describe the behaviour of gases;	E	E	E	E	E	D	D	D	D	D			
CO2: Analyse the underlying thermodynamic principles that govern the properties of chemical systems; and	E	E	E	E	E	E	D	D	D	D			
CO3: Appraise how the thermodynamic laws relate to the changes of equilibrium properties in various processes.	E	E	E	E	E	E	D	D	D	D			

Legend: I – Introductory, E – Enabling, D – Demonstrative
Each letter indicates the expected level of competency that each CO should provide for each PO.

11. Course Content and Plan					
Week	**Topics**	**Learning Outcomes**	**Teaching and Learning Activities**		**Assessment Tasks**
			Teaching Activities	**Learning Activities**	
Class Orientation					
1	OBE Course Syllabus (including VSU Vision Mission, and Quality Policy Statement) Class Policies Requirements Grading System and Activities Learning Guide / Instructional Workbook / Laboratory Manual Submission of requirements Values Integration: Relevance Integrity	○ Promote the Vision, Mission, Goals, Objectives and Core Values of the University	F2F Meeting 1: *Q & A for clarification, setting of expectations, and getting-to-know-each other; Class interaction; Sharing of Ideas; Feedbacks* **VSUEE/VC*:** Familiarization of the virtual classroom	Role play through a video	Class recitations and interactive discussions

	Truth Excellence Satisfaction		Printed Learning Guide (independent study)		
CO1: Assess the fundamental laws that describe the behaviour of gases;					
2	Module No. 1 (Introduction to Chemical Thermodynamics) Lesson No. 1.1 (The thermodynamic system)	○ Familiarize the types and components of thermo-dynamic systems;	F2F Meeting 2: Printed Learning Guide; Independent study	**VSUEE/VC:** Note-taking; Downloading resource materials; Solving assigned tasks	Learning Task (Assignment 1): Due Date: Week 2
3	Module No. 1 (Introduction to Chemical Thermodynamics) Lesson No. 1.2 (Thermodynamic equilibrium and properties)	○ Describe the kinds of thermo-dynamic equilibria and their properties;	F2F Meeting 3: Power point presentation; Class recitation Printed Learning Guide (independent study)	**VSUEE/VC:** Note-taking; Downloading resource materials; Answering lesson exercises	Quiz 1: Due Date: Week 3
4	Module No. 2 (Mathematical Formalism in Chemical Thermodynamics) Lesson No. 2.1 (Total differentials and partial derivatives)	○ Explain the importance of differentials in understanding the properties of a thermo-dynamic system as path or state dependent;	F2F Meeting 4: Moodle Classroom Access Printed Learning Guide; Independent study	**VSUEE/VC:** Note-taking; Downloading resource materials; Solving assigned tasks	Learning Task (Homework 1): Due Date: Week 4
5	Module No. 2 (Mathematical Formalism in Chemical Thermodynamics)		F2F Meeting 5: Power point	**VSUEE/VC:** Note-taking; Download	

	Lesson No. 2.2 (Exact and Inexact differentials)	○ Demonstrate applications of differentials in solving simple problems associated with thermo-dynamic systems;	presentation; Class discussion Printed Learning Guide (independent study)	ing resource materials; Answering lesson exercises	
6	Module No. 3 (Ideal Gases) Lesson No. 3.1 (Properties and kinetic molecular theory of gases)	○ Describe the behavior of ideal gases through changes in independent variables such as pressure, temperature, and volume;	F2F Meeting 6: Printed Learning Guide; Independent study	**VSUEE/VC:** Note-taking; Downloading resource materials; Solving assigned tasks	Learning Task (Problem Set 1): Due Date: Week 6
7	Module No. 3 (Ideal Gases) Lesson No. 3.2 (Ideal gas laws)	○ Illustrate how these gas laws work with the different independent variables that affect the behavior of ideal gases;	F2F Meeting 7: Power point presentation; Group activity Printed Learning Guide (independent study)	**VSUEE/VC:** Note-taking; Downloading resource materials; Answering lesson exercises	Quiz 2: Due Date: Week 7
8	Module No. 4 (Real Gases) Lesson No. 4.1 (Properties of imperfect gases)	○ Explain the molecular interactions, expansion, and compression of imperfect gases; ○	F2F Meeting 8: Printed Learning Guide; Independent study	**VSUEE/VC:** Note-taking; Downloading resource materials; Solving assigned tasks	
9	Module No. 4 (Real Gases) Lesson No. 4.2 (Real gas equation of	○ Describe the salient features of the	F2F Meeting 9: Power point	**VSUEE/VC:** Note-taking; Download	Midterm Exam on Modules 1-4: Due Date: Week 9

	states)	different equations of state being formulated for real gases;	presentation; Individual activity Printed Learning Guide (independent study)	ing resource materials; Answering lesson exercises	
CO2: Analyse the underlying thermodynamic principles that govern the properties of chemical systems;					
10	Module No. 5 (Zeroth Law of Thermodynamics) Lesson No. 5.1 (Thermal evaluation and thermometry)	○ Explain the unsuitability of liquid water as the expanding agent for a thermometer; ○	F2F Meeting 10: Printed Learning Guide; Independent study	**VSUEE/VC:** Note-taking; Downloading resource materials; Solving assigned tasks	Learning Task (Assignment 2): Due Date: Week 10
11	Module No. 5 (Zeroth Law of Thermodynamics) Lesson No. 5.2 (Application of the zeroth law of thermodynamics)	○ Understand clearly the principle of thermal equilibrium;	F2F Meeting 11: Power point presentation; Class recitation Printed Learning Guide (independent study)	**VSUEE/VC:** Note-taking; Downloading resource materials; Answering lesson exercises	Quiz 3: Due Date: Week 11
12	Module No. 6 (First Law of Thermodynamics) Lesson No. 6.1 (Postulates for the First Law of Thermodynamics)	○ Describe the changes in internal energy associated with heat exchanges and work;	F2F Meeting 12: Printed Learning Guide; Independent study	**VSUEE/VC:** Note-taking; Downloading resource materials; Solving assigned tasks	Learning Task (Homework 2): Due Date: Week 12
13	Module No. 6 (First Law of Thermodynamics)		F2F Meeting 13:	**VSUEE/VC:** Note-	Quiz 4: Due Date: Week 13

	Lesson No. 6.2 (Heat capacity and thermochemistry)	○ Demonstrate the thermo-chemistry of reactions based on enthalpy;	Power point presentation; Group discussion Printed Learning Guide (independent study)	taking; Downloading resource materials; Answering lesson exercises	Long Examination on Module Nos. 5 and 6. Due Date: Week 13
CO3: Appraise how the thermodynamic laws relate to the changes of equilibrium properties in various processes.					
14	Module No. 7 (Second Law of Thermodynamics) Lesson No. 7.1 (Postulates of the second law of thermodynamics)	○ Understand the develop-mental theories of the second law of thermo-dynamics;	F2F Meeting 14: Printed Learning Guide; Independent study	**VSUEE/VC:** Note-taking; Downloading resource materials; Solving assigned tasks	Learning Task (Assignment 3): Due Date: Week 14
15	Module No. 7 (Second Law of Thermodynamics) Lesson No. 7.2 (Entropy and the second law of thermodynamics)	○ Differentiate entropy thermodynamically and statistically;	F2F Meeting 15: Power point presentation; Class activity Printed Learning Guide (independent study)	**VSUEE/VC:** Note-taking; Downloading resource materials; Answering lesson exercises	Quiz 5: Due Date: Week 15
16	Module No. 8 (Third Law of Thermodynamics) Lesson No. 8.1 (The principles of the third law of thermodynamics)	○ Illustrate the simple application of entropy on free expansion, adiabatic and isothermal	F2F Meeting 16: Printed Learning Guide; Independent study	**VSUEE/VC:** Note-taking; Downloading resource materials; Solving assigned tasks	

		compressions ; and			
17	Module No. 8 (Third Law of Thermodynamics) Lesson No. 8.2 (Spontaneity of Chemical Reactions)	o Differentiate spontaneous and non-spontaneous processes from thermo-dynamic potentials and functions.	F2F Meeting 17: Power point presentation; Individual task Printed Learning Guide (independent study)	**VSUEE/VC:** Note-taking; Downloading resource materials; Answering lesson exercises	Quiz 6: Due Date: Week 17
18					Final Examination Due Date: Week 18

** VSUEE/VC – VSU E-Learning Environment/ Virtual Classroom*

12. Life-long Learning Opportunities

This course is designed to enable professional teachers acquire knowledge and understanding on the fundamental laws of gases and the underlying principles in chemical thermodynamics. It is envisioned for them to appreciate how thermodynamic laws relate to the changes in equilibrium properties in various processes. These experiences will further help and better equip them in their future career.

13. Contribution of Course to Meeting the Professional Component (%)

General Education: 0 %
Basic Education *(Foundation)*: 0 %
Professional Education (*Major Field): 100 %*

14. References and Other Learning Resources

A. Textbook(s)/ E-Books

Christian, G.D., P.K. Dasgupta and K.A Schug. 2013. Analytical Chemistry. Seventh Edition. John Wiley & Sons Inc., Oregon, USA. 837p.

Danowitz, A.M. 2021. Teach What You Know Day: An Assignment to Bring Peer Learning into Upper Division Chemistry Courses. *Journal of Chemical Education*, 98(5):1556-1561.

De Belen, R.T. and A.R.V. de Belen. 2019. Basic Statistics. Wiseman's Books Trading, Inc. Quezon City, Philippines.

Ebbing, D.D., S.D. Gammon and R.O. Ragsdale. 2003. Essentials of Genera Chemistry. Houghton Mifflin Company, New York, USA

Harris, D.C. 2007. Quantitative Chemical Analysis. Eighth Edition. W.H. Freeman and Company, New York, USA. 878p.

Laitinen, H.A. and W.E. Harris. 2009. Chemical analysis: an advanced text and reference. Second

edition. University of Florida Press, USA.

Mendenhall, W.M. and T.L. Sincich. 2015. Statistics for Engineering and the Sciences. Sixth Edition. Chapman and Hall/CRC Press, Florida, USA.1182p.

Skoog, D.A., D.M. West and F.J. Holler. 2002. Fundamentals of analytical chemistry. 7th edition.

B. Other Learning Resources

Journals

Beck, H.P., M. Zhou, P. Hasanovic, E. Giebelmann and M. Springborg. 2021. Course on the Use of DFT Calculations to Improve Understanding of Phase Diagrams in Solid-State Chemistry. *Journal of Chemical Education*, 98(10):3207-3217.

Chapman, S., J.M. Herniman, G.J. Langley, R. Raja and T.A. Logothetis. 2021. Correction to Redox Aluminophosphates: Applying Fundamental Undergraduate Theory To Solve Global Challenges in the Chemical Industry. *Journal of Chemical Education*, 98(9):3058.

Felmy, A.R. and D. Rai. 1999. Application of Pitzer's Equations for Modeling the Aqueous Thermodynamics of Actinide Species in Natural Waters: A Review. *Journal of SolutionChemistry*, 28(5):533-553

Fu, Q., H. Su, G. Wang and L. Liu. 2021. Using an Infrared Camera to Visualize a Simple Demonstration of Changing the Internal Energy of a System. *Journal of Chemical Education*, 98(10):3277-3283.

Giordano, A.N., D. Gardner, W.W. Kennerly and C. D. Bruce. 2021. Conversation among Physical Chemists: Strategies and Resources for Remote Teaching and Learning Catalyzed by a Global Pandemic. *Journal of Chemical Education*, 98(7):2228-2235.

Grabowski, L.E. and S.R. Goode. 2017. Determining a Solubility Product Constant by Potentiometric Titration to Increase Students' Conceptual Understanding of Potentiometry and Titrations. *Journal of Chemical Education*, 94(5):636-639.

Passos, M.L.C., M. Lucia and M.F.S. Saraiva. 2019. Detection in UV-visible spectrophotometry: Detectors, detection systems, and detection strategies. *Measurement*, 135:896-904

Videos

https://www.youtube.com/watch?v=atN5fqNGTfA

Websites

https://www.britannica.com/science/gravimetric-analysis
https://www.britannica.com/science/turbidimetry
https://www.studyread.com/atomic-absorption-spectroscopy/
http://www.titrations.info/complexometric-titration-end-point-detection
https://www2.chemistry.msu.edu/.../VirtTxtJml/Spectrpy/UV-Vis/uvspec.htm

15. Course Assessment and Evaluation

The performance of students will be assessed and evaluated based on the following:

50 % Midterm + 50 % Final Term = 100% (Overall Final)

Item No,	Assessment Tasks	Percentage Contribution (1)	No. of Times in the Semester (2)	Individual Task % Contribution (1/2)
1	Quizzes	15	6	2.50%/Q
2	LT: Assignment/HW/PS	30	7	4.30%/LT
3	Long Exam	20	1	20.00%/LE

4	Term Exam	35	2	17.50%/TE

COs	Assessment Tasks	Weight in Percent	Minimum Average for Satisfactory Rating	Target and Standards
CO 1	Assignment 1, Homework 1 Problem Set 1 Quiz 1-2 Midterm Exam	35.40	80 %	At least 60 % of the students have at least 80 % score
CO 2	Assignment 2, Homework 2, Quiz 3-4 Long Exam	33.50	80 %	At least 60 % of the students have at least 80 % score
CO 3	Assignment 3 Problem Set 2 Quiz 5-6 Final Exam	31.10	80 %	At least 60 % of the students have at least 80 % score
TOTAL		**100%**		

Grading System (% Passing: 60 %)

Range	Grade	Range	Grade
96-100	1.00	72 - 75	2.25
91- 95	1.25	68 - 71	2.50
86- 90	1.50	64 - 67	2.75
81- 85	1.75	60 - 63	3.00
76- 80	2.00	1 - 59	5.00

16. Course Policies

1) The official virtual classroom is VSU E-Learning Environment (VSUEE) (https://elearning.vsu.edu.ph). A class orientation will be done in relation to the use and navigation of the platform.

2) ZOOM or Google Meet will be used for web-conferencing and real-time class meetings. Username and password link will be posted in VSUEE/VC.

3) Attending the virtual meeting is highly - encouraged but not compulsory. If you cannot attend due to internet connection limitation, there is no problem. Just keep up with the lessons and do all the necessary exercises that is required of you.

4) The virtual meeting is our avenue for synchronous learning. Class interaction and participation is encouraged, sharing of ideas, feedbacking of your outputs and other related concerns in the subject will be done during this time.

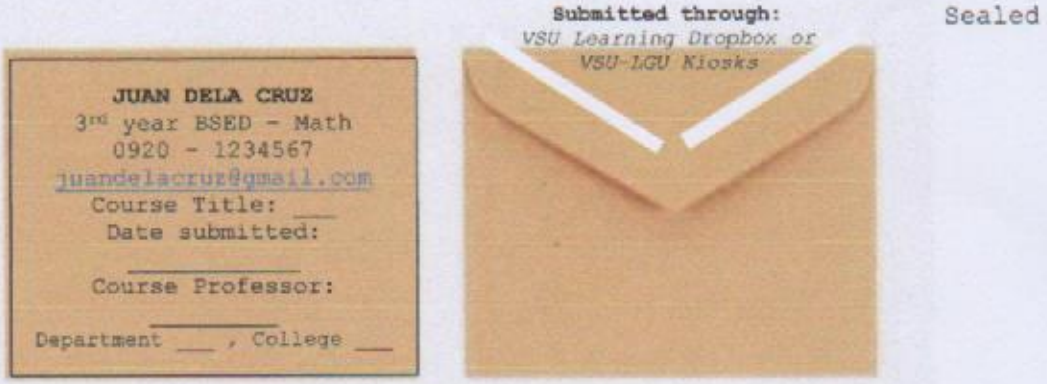
5) All requirements will be submitted preferably through the VSUEE or email but if internet connection is not stable or you do not have an internet connection. You may send your activities to the office through a courier.

ONLINE Submission:

Scan (.pdf) / take a picture (.jpg) / MS Word file (.docx) of the Learning task/activity then send through the VSUEE/VC or email.

OFFLINE Submission:

Place your answers in a SEALED BROWN ENVELOPE. On the envelope, write your FULLNAME, YEAR LEVEL, COURSE, CONTACT NUMBER, EMAIL ADDRESS, COURSE NUMBER, COURSE TITLE, and DATE OF SUBMISSION, COURSE PROFESSOR.



Submit through a courier: The office address is DEPARTMENT OF CHEMISTRY, OFFICE OF THE GRADUATE SCHOOL, Visayas State University, Baybay City, Leyte, Philippines.

VSU Learning Dropbox: Drop your outputs and look for the VSU Learning Dropbox (College of Arts and Sciences), located at the parking space near ATM Machine, Lower Guard Post 2.

VSU – Academic/LGU Kiosks: Drop your outputs in the designated VSU – Academic/LGU Kiosks of your respective LGU.

6) Original copies of all answers, solutions, and laboratory reports should be kept by the student, put in a folder/envelope one after the other, and should be bound together to form a "proftfolio" as part of the final requirements of the course.

7) In answering the Learning Task/Activities, it can be done in any of the following:
   a. Use the Learning Guide in Chemistry 208 (type of IM), in answering the given activities/tasks. Additional sheet of paper may be used as necessary.
   b. Handwritten or encoded in MS Word file format
   c. General format for additional sheet either handwritten/Word file:
      i. A4 size bond paper
      ii. 1" margin all sides
      iii. Arial, 12 font size, double space (for encoded outputs)

8) Quizzes is set on VSUEE - VC. All quizzes are announced and will open every after a topic has been discussed. You have one week to comply with the quiz and answer it anytime you think that you are ready.

9) This Learning Guide in Chem 208 (type of IM) is our official instructional material in this subject. It will serve as your guide for the whole semester. Whether you have internet connection or not, use it.

10) In the submission of activities, there are deductions for late submissions but ON-TIME submission is much appreciated.

11) If you have any inquiries/clarifications, you may contact the course instructor/professor during official class schedule; Monday to Friday only.

12) All students are reminded to observe all policies, regulations, and rules of the university and other related laws of the land and are advised to read, understand, and practice the provisions of the VSU Student Manual.

13) Lastly, as we embark in this "new normal". Let us have an open mind and heart as we adjust in this new way of delivering the teaching-learning process and still continue to aim for quality in education.

This class policy serves as our written agreement for the whole semester. If there are any changes to enhance the class learning opportunity within the semester, it will be communicated accordingly.

17. Course Materials and Facilities Available

- Lecture notes and videos
- LCD/LED Projector and Projector Screen
- Classroom filled with armchairs
- Electric fans and fluorescent light
- Computer table, whiteboard, and markers
  Updated periodic table

18. Revision History

Revision number	Date of Revision	Date of implementation	Highlights of Revision	Revised by
0	March 8, 2021	March 15, 2021	New Normal Format (ISO)	Felix M. Salas
1	Feb. 10, 2022	Feb. 15, 2022	Updated References and other learning resources	Felix M. Salas

19. Preparation

	Name	Signature	Date Signed
Prepared by	FELIX M. SALAS		Feb. 10, 2023

III. INSTRUCTOR/PROFESSOR INFORMATION

1. Name of Instructor/Professor	Felix M. Salas
2. Office and Department	Department of Pure and Applied Chemistry
3. Telephone/Mobile Numbers	Office: 053-565-0600 (loc 1032); Mobile: 09088103742; Residence:053-563-0271
4. Email Address	felix.salas@vsu.edu.ph

5. Consultation Time	4:00-5:00 MWF; 11:00 am -13:00 pm Saturday

20. Department Instructional Materials Review Committee:

Committee	Name	Signature	Date Signed
Member	MARIA ROBELYN A. INSIK		
Member	ALLAN A. RAMAL		
Department Head:	ELIZABETH S. QUEVEDO		

	Name	Signature	Date Signed
Verified by:	ANABELLA B. TULIN Dean, OGS		
Validated by:	NANCY D. ABUNDA Head, IMD		

Note:

1) The number of POs will depend on each degree program offered
2) COs and Relationship to POs
   a. (I) - **Introductory** – an Introductory Course to an outcome
   b. (E) - **Enabling** – an Enabling Course or a course that strengthens the outcome
   c. (D) - **Demonstrated** – a Demonstrative Course or a course demonstrating an outcome.

Distribution of copies: OIMD, College, Department, Faculty and ODQA