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CHEM 2220; ORGANIC CHEMISTRY II; FALL SEMESTER 2020
(Credits: 3.0)

Course Instructor: V. Prakash Reddy

Class Time and place: MWF 8:00 A.M. to 8:50 A.M.; Castleman Hall; The Castleman Hall complies with the social distance requirements. The course may transition to fully online during the semester at any time, and in that case the online classes will be conducted at the same class time as scheduled in this syllabus. Students can contact the instructor through email, Canvas, telephone, and through pre-arranged Zoom sessions.

Office: 234 Schrenk Hall.

Office Hours: Tue. and Thurs., 8:50 A.M. to 9:50 A.M., or any other time by appointment Tel: 573-341-4768; Emails will be replied within two business days; for immediate response, telephone calls are encouraged.

Text Book: Organic Chemistry, Graham Solomons and Craig Fryhle, 12th Edition, John Wiley, New York, **2014** (Required; available in "AutoAccess" through Canvas); "Sapling Learning"; MacMillan Higher Education (Required; available through Canvas).

Supplementary Material: Study Guide and Solutions Manual, Graham Solomons, Craig Fryhle, and Robert Johnson, John Wiley, New York (available in the S&T book store); Molecular Model Set for Organic Chemistry, Prentice Hall (or any other molecular models); Sophomore Organic Chemistry By Inquisition I and II (Kevin Burgess, Inquisition Press 2016).

Grading Policy: The exam schedules are as follows: **Exam 1: Wed., Sept. 30 (50 min; 100 points); Exam 2: Mon., Nov 9, (50 min; 100 points); Exam 3: Fri., Dec. 4 (50 min; 100 points); Exam 4: Final ACS comprehensive exam, Monday, Dec. 14, 2020; 12:30 P.M. to 2:30 P.M. (2 hours; 50 points);** Homework assignments (120 pts; 8 x 15 pts); **Total pts: 470.** The homework problems will be assigned online from the "Sapling" on Canvas. The homework assignments are due on the dates shown in the detailed course outline below (usually at the end of each of the chapters). The exams will be posted online in Canvas from 8:00 A.M. to 5:00 P.M. on the day of the exams. The final comprehensive ACS exam comprises 70 multiple-choice questions and includes topics from all chapters in the text (i.e., contents from the first and the second semester), and each of the first three exams comprise 20 multiple-choice questions (ACS study guide (study material: "Preparing for your ACS examination in organic chemistry"; QD 275.P74 2002). The final grade assignment will be as follows: **>85% (A), 60–85% (B), 45–60% (C), and 35–45% (D).** You would have the opportunity to earn extra-credit scores throughout the semester, upto a maximum of 20 points. The Final ACS exam is **required** and the missed ACS exam would result in an incomplete grade ("I"). Please note that class

attendance is not mandatory for this Course (i.e., no penalty for missed classes). Recognizing that attendance may be more difficult for some students in the context of COVID, all course materials and lecture recordings will be uploaded into the Canvas course site, as soon as they will be available. The grades will be posted in the Canvas within two business days of the exam.

Course Prerequisite Concepts (from Organic Chemistry I): Nucleophilic and free-radical substitution reactions; electrophilic and free-radical additions to alkenes (regioselectivities); oxidation and reduction reactions; nucleophilic addition reactions (e.g., Grignard reactions); $^1\text{H}/^{13}\text{C}$ NMR and IR spectroscopy; relative stabilities of carbocations, free-radicals, and carbanions.

Course Objective and Contents: This course will cover topics on fundamental reactions in organic chemistry, including nucleophilic additions, electrophilic substitutions; nucleophilic substitutions, including acyl nucleophilic substitution reactions; and reaction mechanisms. Each of these reactions have analogs in the enzyme-catalyzed reactions (that you may encounter in biochemistry courses) and the reactions mechanisms are also very similar. Thus, the topics covered in this semester would help you connect with real world challenges in biochemical as well as in materials sciences. The following chapters from the text book will be covered in this course.

Chapter 13. Conjugated Unsaturated Systems (Wed., Aug. 26 to Wed., Sept. 2)

Chapter 14. Aromatic Compounds (Wed., Sept. 4 to Wed., Sept. 14)

Chapter 15. Reactions of Aromatic Compounds (Wed., Sept. 16 to Fri., Sept. 25)

Chapter 16. Aldehydes and Ketones (Mon., Oct. 12, to Wed., Oct. 21)

Chapter 17. Carboxylic Acids and Their Derivatives (Fri., Oct. 23 to Wed., Oct. 28)

Chapter 18. Reactions at the α -Carbon of Carbonyl Compounds (Fri., Oct. 30 to Wed., Nov. 4)

Chapter 19. Condensation and Conjugate Addition Reactions of Carbonyl Compounds (Wed., Nov. 11 to Wed., Nov. 16)

Chapter 20. Amines (Fri., Nov. 18 to Wed., Nov. 30)

Tentative schedule of the exam contents: Exam 1 (Chapters 13, 14, 15); Exam 2 (Chapters 16, 17, 18); Exam 3 (Chapters 19 and 20); Final Exam (ACS Comprehensive exam).

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Addendum

I. Tentative Detailed Course Outline:

- Mon., Aug. 24 Introduction to the course contents
- Wed., Aug. 26 Chapter 13; Conjugated unsaturated systems; introduction; page 573; Stability of allyl radicals; pages 573–576
- Fri., Aug. 28 Chapter 13; Conjugated unsaturated systems; The allyl cation; pages 577– 582; Alkadienes and polyunsaturated hydrocarbons; pages 582–583; Stability of conjugated dienes; pages 586–587
- Mon., Aug. 31 Chapter 13; Conjugated unsaturated systems; Resonance stabilization of 1,3-butadiene; pages 583–584; UV-vis spectroscopy; pages 587–593
- Wed., Sept. 2 Chapter 13; Conjugated unsaturated systems; Electrophilic 1,4-additions and 1,2-additions to conjugated dienes; pages 595–597; Diels–Alder reaction; pages 599, 601–605
- Fri., Sept. 4 Chapter 14; Aromatic Compounds; Nomenclature; pages 618–621; Electrophilic substitutions of aromatic compounds; page 622 (**Homework 1 is due**)
- Mon Sept 7 Labor Day; No class
- Wed., Sept. 9 Chapter 14; Aromatic Compounds; Resonance stabilization of aromatic compounds; 624–627; Aromatic, nonaromatic, and anti-aromatic (not in the book) compounds; Huckel's $4n+2$ rule for aromatic compounds and $4n$ rule for anti-aromatic compounds (not in the book); 629–634
- Fri., Sept. 11 Chapter 14; Aromatic Compounds; Predicting acidity and relative reactivity (i.e., rates of reactions) of aromatic compounds, further discussion with examples from scientific literature and pages 629–634; Heterocyclic aromatic compounds; pages 639–641
- Mon., Sept. 14 Chapter 14; Aromatic Compounds; Heterocyclic aromatic compounds; pages 639–641; NMR and IR spectroscopy of aromatic compounds; pages 644– 648
- Wed., Sept. 16 Chapter 15; Reactions of aromatic compounds; Electrophilic aromatic substitution reactions and mechanism; 661–664; electrophilic halogenations; pages 665–667 (**Homework 2 is due**)
- Fri., Sept, 18 Chapter 15; Friedel–Crafts reactions; pages 668–672; Synthetic applications of Friedel–Crafts reactions (including Clemmensen reduction and Wolff–Kishner reduction); pages 673–675
- Mon., Sept. 21 Chapter 15; Friedel–Crafts reactions; Reactions of aromatic compounds; *Ortho-para-* directors; pages 677–681; *Meta* directors; pages 681–682
- Wed., Sept. 23 Chapter 15; Friedel–Crafts reactions; Reactions of aromatic compounds; Activating and deactivating groups; page 683–684; Directing effects; pages 685, 689–691
- Fri., Sept. 25 Chapter 15; Friedel–Crafts reactions; Reactions of aromatic compounds; Additions to double bonds of alkenyl benzenes (electrophilic and free-radical additions); page 687
- Mon., Sept. 28 Review of chapter 13, 14, and 15 (**Homework 3 is due**)
- Wed., Sept. 30 Exam 1
- Fri Oct 2 Fall Break; No class
- Mon., Oct. 12 Chapter 16; Aldehydes and Ketones; Nomenclature; pages 712–713; Synthesis of aldehydes, pages 715–718

Wed., Oct. 14 Chapter 16; Aldehydes and Ketones; Synthesis of ketones by Friedel–Crafts reactions and oxidations; pages 720–721; Nucleophilic addition reactions (including reductions and Grignard reactions; cyanohydrins); pages 723–726; pages 746–747

Fri., Oct. 16 Chapter 16; Aldehydes and Ketones; Hemiacetals and acetals 726–729; Hydrazones and Wolff–Kishner reduction pages 733–774

Wed., Oct. 21 Chapter 16; Aldehydes and Ketones; Wittig reactions; Pages 737–739; Tollen's test and spectroscopy; pages 743–745

Fri., Oct. 23 Chapter 17; Carboxylic acids and derivatives; Nomenclature, acidity of carboxylic acids and spectroscopy; Pages 763–770 (**Homework 4 is due**)

Mon., Oct. 26 Chapter 17; Preparation Carboxylic acids and derivatives; of carboxylic acids; pages 770–772; Reactions of acid halides, pages 773–776

Wed., Oct. 28 Chapter 17; Carboxylic acids and derivatives; Synthesis and reactions of esters, anhydrides; pages 777–782; Synthesis and reactions of amides pages 784–786

Fri., Oct. 30 Chapter 18; Reactions of carbonyl compounds; enolates, racemization and α -halogenation; pages 812–819 (**Homework 5 is due**)

Mon., Nov. 2 Chapter 18; Reactions of carbonyl compounds; enolates and α -alkylations; pages 821–829

Wed., Nov. 4 Chapter 18; Reactions of carbonyl compounds; acylation of enolates; pages 829–833

Fri., Nov. 6 Review of chapters 16, 17, and 18 (**Homework 6 is due**)

Mon Nov 9 Exam 2

Wed., Nov. 11 Chapter 19; Conjugate additions of carbonyl compounds; Claisen condensations, 851–855; Aldol reactions; 856–863; Michael additions; 869–871

Fri., Nov. 13 Chapter 19; Conjugate additions of carbonyl compounds; Aldol reactions; 856–863; Michael additions; 869–871

Mon., Nov. 16 Chapter 19; Conjugate additions of carbonyl compounds; Michael additions; 869–871

Wed., Nov. 18 Chapter 20; Amines; Structure, nomenclature, and basicity; pages 890–898 (**Homework 7 is due**)

Fri., Nov. 20 Chapter 20; Amines;; Preparation, 901–908

Mon Nov 23 to Fri Nov 27 Thanksgiving Break; No class

Mon., Nov. 30 Chapter 20; Amines; Reactions and spectroscopic analysis; Pages 909–19

Wed., Dec. 2 Review for chapters 19 and 20 (**Homework 8 is due**)

Fri., Dec. 4 Exam 3

Mon., Dec. 14 Final ACS exam; Mon Dec 14, 2020 12:30 p.m. to 2:30 p.m.

II. Boilerplate: Missouri S&T Campus and UM System Policies

Statement about Copyright, FERPA, and Use of Video

It is vitally important that our classroom environment promote the respectful exchange of ideas. This entails being sensitive to the views and beliefs expressed during discussions whether in class or online. Please speak with me before recording any class activity. It is a violation of University of Missouri policy to distribute such recordings without my authorization and the permission of others who are recorded. More information is provided online.

Well-Being and UCARE

Any of us may experience strained relationships, increased anxiety, feeling down, alcohol/drug misuse, decreased motivation, challenges with housing and food insecurity, etc. When your mental well-being is negatively impacted, you may struggle academically and personally. If you feel overwhelmed or need support, please make use of S&T's confidential mental health services at no charge. For a quick guide to campus resources that address specific issues please visit our Well-Being Referral Guide, available as a website at <https://minerwellness.mst.edu/well-being-referral-guide/>. If you are concerned about a friend or would like to consult with a Care Manager, please make a UCARE referral for support and assistance. <https://stuaff.mst.edu/ucare/>.

Student Honor Code and Academic Integrity

- The Honor Code all students are expected to follow can be found at this link: <http://stuco.mst.edu/honor-code/>.
- Page 30 of the Student Academic Regulations handbook describes the student standard of conduct relative to the University of Missouri System's Collected Rules and Regulations section 200.010, and offers descriptions of academic dishonesty including cheating, plagiarism or sabotage (<http://registrar.mst.edu/academicregs/index.html>).
- Additional guidance including the University's Academic Dishonesty Procedures is available at <http://academicsupport.mst.edu>.
- Other resources for students regarding ethics and integrity can be found at <http://academicsupport.mst.edu/academicintegrity/studentresources-ai>.

Accessibility and Accommodations

It is the university's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on a disability, please contact Student Disability Services at (573) 341-6655, sdsmst@mst.edu, visit <http://dss.mst.edu/> for information.

Nondiscrimination, Equity, and Title IX

Missouri University of Science and Technology is committed to the safety and well-being of all members of its community, and to creating an environment free from discrimination and harassment.

The University does not discriminate on the basis of race, color, national origin, ancestry, religion, sex, pregnancy, sexual orientation, gender identity, gender expression, age, disability, protected veteran status, and any other status protected by applicable state or federal law. As used in this policy, the word "sex" is also inclusive of the term "gender."

Additionally, US Federal Law Title IX states that no member of the university community shall, on the basis of sex, be excluded from participation in, or be denied benefits of, or be subjected to discrimination under any education program or activity. Violations of this law include sexual harassment, sexual assault, dating/domestic violence, and stalking.

In accordance with The Collected Rules and Regulations University of Missouri, Missouri S&T requires that all faculty and staff members report, to the Missouri S&T Equity Officer, any notice of discrimination disclosed through communication including but not limited to direct conversation, email, social media, classroom papers and homework exercises.

Missouri S&T's Equity Officer and Title IX Coordinator is Chief Diversity Officer Neil Outar. Contact him (naoutar@mst.edu; (573) 341-6038; 203 Centennial Hall) to report violations of the university's nondiscrimination policies, including Title IX. To learn more about resources and reporting options (confidential and non-confidential) available to Missouri S&T students, staff, and faculty, please visit <http://titleix.mst.edu>.

Classroom Egress Maps

For all in-person instruction, faculty should explain where the classroom emergency exits are located. Classroom egress maps are posted at <http://designconstruction.mst.edu/floorplan/>.