Psychophysiology of Sleep and Circadian Rhythms

Special Topic

BIOL 4590.004, BIMS 4590.001

Department of Life Sciences

Spring 2020

A. COURSE INFORMATION

Course number/section:  BIOL 4590.004, BIMS 4590.001
Class meeting time:  Tue-Thu, 9:30 to 10:45
Class location:  Bay Hall 202
Course Website:  http://bb9.tamucc.edu

B. INSTRUCTOR INFORMATION

Instructor:  James C. Miller, Ph.D.
Office location:  TH 131
Office hours:  Tue-Thu, 8:00 to 9:20, Wed 10:00 to 12:00
Telephone:  361-825-2140
e-mail:  james.miller@tamucc.edu
Appointments:  by email

C. COURSE DESCRIPTION

Catalog Course Description

In this seminar course, students will learn to dispel myths about sleep and fatigue, to estimate circadian rhythm parameters, to read a sleep histogram, to perform frequency analysis, to implement the two-process model, to estimate fatigue effects on human performance, to analyze shiftwork schedules, and to initiate forensic fatigue analyses.

Extended Course Description

Unit 1. Circadian rhythm physiology
   Body daily rhythms
   Circasemidian rhythm
   Jet lag and shift lag
   Cognitive function rhythm
Quantitative estimation of circadian rhythm parameter values by least squares cosine curve fits in a spreadsheet (cosinor analysis)

**Unit 2.** Sleep physiology
- Electroencephalography (EEG) of sleep
- Sleep stages and cycling
- Circadian rhythms in sleep and sleep propensity
- Sleep aids, antagonists, and pathologies
- Cognitive fatigue due to inadequate sleep
- Sleep inertia
- Discrete Fourier transform (DFT) analysis in a spreadsheet

**Unit 3.** Quantitative modeling of sleep and circadian rhythm effects on cognitive fatigue
- The two-process model
- Review of fatigue models used internationally in industry and the military
- Spreadsheet implementation of the two-process model, based upon my work on the development of the DoD's SAFTE/FAST model

**Unit 4.** The history of cognitive fatigue research, based in part upon my chapter on that subject in *The Handbook of Operator Fatigue*
- The Harvard Fatigue Lab & WWII research
- USAF research
- Computerized tools used for psychophysiological and cognitive performance testing
- Contemporary emphases on fatigue risk management systems (FRMS)
- Performance variability as a fatigue estimator, based on my work on the development of the SDLP measure used in highway research

**Unit 5.** Real-world applications
- Descriptions of major applied research projects in which I participated, including two major DoT commercial driver investigations and a large-scale US Coast Guard cutter crew fatigue investigation
- Fundamentals of shiftwork scheduling, based upon my book of the same name
- Forensic analysis of the contribution of fatigue to highway and aviation accidents, based upon my books, *Fatigue (aviation)*, and *Anatomy of a Fatigue-Related Accident*

**D. PREREQUISITES AND COREQUISITES**

**Prerequisites**
- Biology 3430-Physiology
- MATH 1314-Trigonometry (sine and cosine waveforms)—taken either in high school or college or by permission of instructor
MATH 1442 Statistics for Life (correlation, variance & standard deviation)

**Corequisites:** None

**Supplies:** None

**E. REQUIRED READINGS**

**Probable List of Readings** (electronic, furnished by the instructor)


### F. STUDENT LEARNING OUTCOMES AND ASSESSMENT

Assessment is a process used by instructors to help improve learning. Assessment is essential for effective learning because it provides feedback to both students and instructors. A critical step in this process is making clear the course’s student learning outcomes that describe what students are expected to learn to be successful in the course. The student learning outcomes for this course are listed below. By collecting data and sharing it with students on how well they are accomplishing these learning outcomes students can more efficiently and effectively focus their learning efforts. This information can also help instructors identify challenging areas for students and adjust their teaching approach to facilitate learning.

By the end of this course, students should be able to:

1. Dispel myths about sleep and fatigue
2. Estimate circadian rhythm parameter values by least squares cosine curve fits in a spreadsheet
3. Read a sleep histogram to estimate sleep quantity and quality
4. Perform discrete Fourier transform (DFT) analysis in a spreadsheet to decompose a complex waveform
5. Implement the two-process model in a spreadsheet to estimate fatigue effects
6. Estimate fatigue effects on human performance through the use of statistical performance variability
7. Analyze the quality of a shiftwork schedule with respect to fatigue risk management
8. Conduct a forensic analysis of the contribution of fatigue to an accident

G. INSTRUCTIONAL METHODS AND ACTIVITIES

In seminar sessions, students will deliver 10-minute summaries of assigned readings in Units 1 through 4. Each presentation and will be graded with a friendly rubric aimed at improving speaking style. The presentations will be followed by a group discussion led by the instructor. The instructor will also lecture on one or more subjects and assign additional readings for subsequent presentations and discussions. The readings will include but not be limited to those listed above.

Outside of seminar sessions, the students will undertake spreadsheet analyses of introductory quantitative problems assigned by the instructor. The analyses will be graded by the instructor for completeness and accuracy. Each student will also select a topic of interest and write a concise, 1000-word review of that topic. The paper will be graded by the instructor for accuracy and clarity.

There will be three unit exams and a final exam.

H. MAJOR COURSE REQUIREMENTS AND GRADING

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>% of FINAL GRADE</th>
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<tbody>
<tr>
<td>Unit Exams (3)</td>
<td>30%</td>
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<tr>
<td>Final Exam</td>
<td>20%</td>
</tr>
<tr>
<td>Spreadsheet Analyses (3)</td>
<td>10%</td>
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<tr>
<td>Presentations</td>
<td>20%</td>
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<tr>
<td>Paper</td>
<td>20%</td>
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Final grading: A >=90%, B 80% <= 89%, C 70% <= 79%, D 60% <= 69%, F <60%

I. COURSE CONTENT/SCHEDULE

<table>
<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
<th>READING</th>
<th>ASSIGNMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit 1. Circadian rhythm physiology</td>
<td>Lee et al. 2013</td>
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<td>Miller 2013c</td>
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<tr>
<td>21 Jan</td>
<td>Body temperature rhythm</td>
<td>Landolt et al. 1995</td>
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<tr>
<td>23 Jan</td>
<td>Circasemidian rhythms</td>
<td>Miller 2006</td>
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<tr>
<td>28 Jan</td>
<td>Jet lag and shift lag</td>
<td>Arendt &amp; Marks 1982</td>
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<td></td>
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<td>Paul et al. 2011</td>
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1 Section 1
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<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Page/Author</th>
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</thead>
<tbody>
<tr>
<td>30 Jan</td>
<td>Cognitive function rhythm</td>
<td>Miller 2015b</td>
</tr>
<tr>
<td>4 Feb</td>
<td>Quantitative estimation of circadian rhythm parameter values (cosinor analysis)</td>
<td>Cornelissen 2014</td>
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<tr>
<td>6 Feb</td>
<td><strong>Unit 1 Exam</strong></td>
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<td></td>
<td><strong>Unit 2. Sleep physiology</strong></td>
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<tr>
<td>11 Feb</td>
<td>Electroencephalography (EEG) of sleep</td>
<td>Campbell 2009</td>
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</table>
| 13 Feb | Sleep stages and cycling                                              | Hauri 2013<sup>2</sup>  
                   |                   | Miller 2013c<sup>3</sup> |
| 18 Feb | Circadian rhythms in sleep and sleep propensity                        | Waterhouse et al. 
                   |                   | 2012  
                   |                   | Morris & Miller  
                   |                   | 1996 |
| 20 Feb | Sleep aids, antagonists, and pathologies                               | Van Reen et al.  
                   |                   | 2011,2013  
                   |                   | Mayo Clinic 2018,  
                   |                   | 2019  
                   |                   | Miller 2015b |
| 25 Feb | Cognitive fatigue due to inadequate sleep, MWT, MSLT                   | Lichstein et al.  
                   |                   | 1997  
                   |                   | Doghramji et al.  
                   |                   | 1997  
                   |                   | Arand et al.  
                   |                   | 2005  
                   |                   | Miller 2013c |
| 27 Feb | Sleep inertia                                                          | Jewett et al.  
                   |                   | 1999  
                   |                   | Bruck & Pisani  
                   |                   | 1999  
                   |                   | Signal 2008  
                   |                   |                   |
| 3 Mar  | Discrete Fourier transform (DFT) analysis                              | Miller 2017       |
| 5 Mar  | **Unit 2 Exam**                                                       |                   |
|        | **Spring Break, Midterm grades**                                      |                   |
| 17 Mar | The two-process model                                                  | Borbely & 
                   |                   | Achermann 1999 |
| 19 Mar | Review of fatigue models used internationally in industry and the military | Hursh et al.  
                   |                   | 2004  
                   |                   | Caldwell et al.  
                   |                   | 2009  
                   |                   | Spreadsheet 2 due |
| 24 Mar | Implementation of the two-process model                                | Borbely & 
                   |                   | Achermann 1999 |

<sup>2</sup> Chapter 1, two sections: *Stages of Human Sleep* and *Sleep Cycles*.

<sup>3</sup> Section 1
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<thead>
<tr>
<th>Date</th>
<th>Event/Assignment</th>
<th>Notes</th>
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<tr>
<td>26 Mar</td>
<td><strong>Unit 3 Exam</strong></td>
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<td><strong>Unit 4. The history of cognitive fatigue research</strong></td>
<td>Miller 2012</td>
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<td></td>
<td></td>
<td>Miller 2013b</td>
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<tr>
<td>31 Mar</td>
<td>The Harvard Fatigue Lab &amp; WWII</td>
<td>Miller 2012</td>
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<tr>
<td>2 Apr</td>
<td>USAF Research</td>
<td>Miller 2013b</td>
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<td></td>
<td></td>
<td>Miller &amp; Rokicki 1996</td>
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<tr>
<td>7 Apr</td>
<td>Computerized tools used for psychophysiological and cognitive performance testing</td>
<td>Englund et al. 1987</td>
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<td>9 Apr</td>
<td>Contemporary emphases on fatigue risk management systems (FRMS)</td>
<td>Konz 1998</td>
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<td>Moore-Ede 2010</td>
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<td>Miller 2013c</td>
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<td></td>
<td></td>
<td>Jankowski 2017</td>
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<tr>
<td>10 Apr</td>
<td><strong>Last day to drop classes</strong></td>
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<tr>
<td>14 Apr</td>
<td>Performance variability as a fatigue estimator</td>
<td>McClernon &amp; Miller 2011</td>
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<td></td>
<td></td>
<td>Miller 2014</td>
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<td></td>
<td>Spreadsheet 3 due</td>
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<tr>
<td>16 Apr</td>
<td><strong>Unit 4 Exam</strong></td>
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<tr>
<td>16 Apr</td>
<td><strong>Last day to apply for Spring graduation</strong></td>
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<td><strong>Unit 5. Real-world applications</strong></td>
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<tr>
<td>21 Apr</td>
<td>Descriptions of applied research (lecture)</td>
<td>Miller &amp; Mackie 1978</td>
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<td></td>
<td></td>
<td>Miller et al. 1985</td>
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<td></td>
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<td>Miller &amp; Narvaez 1986</td>
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<td></td>
<td></td>
<td>Gawron et al. 1990</td>
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<td></td>
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<td>Gevins et al. 1990</td>
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<td>Miller 1993</td>
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<td>Miller et al. 1993</td>
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<td>Wylie et al. 1996</td>
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<td></td>
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<td>Miller et al. 1998</td>
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<td>Miller et al. 2003</td>
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<tr>
<td>23 Apr</td>
<td>Fundamentals of shiftwork scheduling (lecture)</td>
<td>Miller et al. 2003</td>
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<td>Miller 2013c</td>
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<td>Miller 2015a</td>
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<td>Paul &amp; Miller 2004, 2005</td>
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<td>Paul et al. 2010</td>
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4 Sections 4 & 5
5 Sections 2 & 3
Note: Changes in this course schedule may be necessary and will be announced to the class by the Instructor. The assignments and exams shown are directly related to the Student Learning Outcomes described in Section F.

J. COURSE POLICIES

Attendance/Tardiness
Prompt attendance is required at seminar

Late Work
Late work may receive a 10% penalty

Extra Credit
None

Cell Phone Use
No communications during seminar

Laptop Use
May be used during seminar

Food in Class
Allowed during seminar if not a distraction

Missed Exam
Situations that allow the taking of a make-up exam include:

- Documented emergency visits to the emergency room, physician, or dentist;
- Pre-approved job, graduate and professional school interviews;
- Death of close family members (siblings, in-laws, parents, aunts, uncles, step-parents, grandparents, great-grandparents, and first cousins); and
- University pre-approved absences as described in the Catalogue and Student Handbook and scheduled in advance of the exam day.

Participation
Presentations and group discussion participation are required.
K. COLLEGE AND UNIVERSITY POLICIES

- **Academic Integrity (University)**

  University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one’s own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a failing grade.

- **Classroom/Professional Behavior**

  Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor’s ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

- **Statement of Civility**

  Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex, ethnic/racial origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

- **Deadline for Dropping a Course with a Grade of W (University)**

  I hope that you never find it necessary to drop this or any other class. However, events can sometimes occur that make dropping a course necessary or wise. Please consult with your academic advisor, the Financial Aid Office, and me, before you decide to drop this course. Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class. Please consult the Academic Calendar (http://www.tamucc.edu/academics/calendar/) for the last day to drop a course.

- **Grade Appeals (College of Science and Engineering)**

  As stated in University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to
demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at http://www.tamucc.edu/provost/university_rules/index.html, and the College of Science and Engineering Grade Appeals webpage at http://sci.tamucc.edu/students/GradeAppeal.html. For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

- **Disability Services**

  The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call (361) 825-5816 or visit Disability Services in Corpus Christi Hall 116.

  If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816. http://disabilityservices.tamucc.edu/

- **Statement of Academic Continuity**

  In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi; this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.

## L. OTHER INFORMATION

- **Academic Advising**

  The College of Science & Engineering requires that students meet with an Academic Advisor as soon as they are ready to declare a major. The Academic Advisor will set up a degree plan, which must be signed by the student, a faculty mentor, and the department chair. Meetings are by appointment only; advisors do not take walk-ins. Please call or stop by the Advising Center to check availability and schedule an appointment. The College’s Academic Advising Center is located in Center for Instruction 350 or can be reached at (361) 825-3928.
GENERAL DISCLAIMER

I reserve the right to modify the information, schedule, assignments, deadlines, and course policies in this syllabus if and when necessary. I will announce such changes in a timely manner during regularly scheduled lecture periods.