Wilkes University Curriculum Committee

PROPOSAL SUBMITTAL FORM

Directions:

- Use this set of forms for all proposals sent to the Curriculum Committee.
- Pages 1-3 of this document are required. Any unnecessary forms should be deleted from the packet before submissions. If multiple forms are needed (course addition, course deletion, etc), simply copy and paste additional forms into this packet.
- Note that all new programs (majors and minors), program eliminations, significant program revisions and all general education core revisions must be reviewed and approved by the Provost and Academic Planning Committee (APC) prior to submission to the Curriculum Committee. The Provost will make the decision if a program revision requires APC review.
- Completed and signed forms are due no later than the second Tuesday of every month. Submit one signed original hard copy and a scanned electronic copy with all signatures to the Chair of the Curriculum Committee.

   Electrical Engineering and Physics
   (570) 408-4885 / jgilmer@wilkes.edu

2. Proposal Title: **Introduction to Weapons Systems**

3. Check only one type of proposal: (double click on the appropriate check box and change default value to “checked”).

☐ New Program. (Major or Minor Degree Programs). This requires prior review and approval by the Provost and APC.
☐ Elimination of Program. (Major or Minor Degree Programs). This requires prior review and approval by the Provost and APC.
☐ Program Revision. Significant revisions to a program require review and approval by the Provost. The Provost determines if review and approval by APC is necessary.
☐ General Education Revision. Submissions only accepted from the General Education Committee (GEC). Must be reviewed and approved by the Provost.
☒ Creation of new departments, elimination of existing department. This requires prior review and approval by the Provost and APC.
☐ Course additions or deletions not affecting programs (such as elective courses, transition of “topics” courses to permanent courses).
☐ Change in course credit or classroom hours.
☐ Incidental Changes. Includes changes in course/program title, course descriptions, and course prerequisites. (Although these changes do require approval by the Curriculum Committee, they do not go before the full faculty for approval).
☐ Other (Specify)
4. Indicate the number of course modification forms that apply to this proposal:

1 Course Addition Form (plus syllabi)
1 Course Deletion Form
1 Course Change Form

5. Executive Summary of Proposal.

Briefly summarize this proposal. The breadth and depth of this executive summary should reflect the complexity and significance of the proposal. Include an overview of the proposal, background and reasoning behind the proposal and a description of how the proposal relates to the mission and strategic long-range plan of the unit and/or university. For incidental changes a one or two sentence explanation is adequate.

This Introduction to Weapons Systems course is intended to serve as a technical elective for EE, ME, and EGM majors, particularly those who have a potential interest in the aerospace or other military related fields. Over the years Wilkes has had numerous graduates enter such jobs at Tobyhanna Army Depot (our region’s largest employer), Naval Surface Weapons Center Dahlgren, Aberdeen Proving Ground, Lockheed-Martin, and some other employers. This course is really about applications of physics, with an emphasis on understanding the military context and systems. As such the course visits, at an introductory level, a variety of topics ranging from explosives to nuclear weapons and guidance control systems that are not specifically addressed in other courses, but are important to our students as they interview for and enter prospective jobs in this domain.

6. Other specific information. (Not applicable for incidental changes.)

What other programs, if any, will be affected by this proposal? Describe what resources are available for this proposal. Are they adequate? What would be the effect on the curriculum of all potentially affected programs if this proposal were adopted? Include any potential effects to the curriculum of current programs, departments and courses.

The proposed course would typically be taken by EE, ME, and EGM majors seeking a technical elective during either junior or senior year. It is, however, available to any majors who have taken a Physics 1 and are at least enrolled in a Physics 2 course. Currently the EE and ME departments have three people who would feel comfortable teaching this course (J. Gilmer, D. Carey, and R. Taylor) and it is likely adjuncts could be found as well if that was necessary. The engineering curricula require technical electives, and this one meets that need for all three programs mentioned. This course has been offered twice as a topics course with final enrollments of 16 and 24, which is pretty good for a technical elective. This course does compete with other potential technical electives.

7. Program Outline. (Not applicable for incidental changes).

A semester-by-semester program outline as it would appear in the bulletin for a new program or any modified program with all changes clearly indicated.

Not applicable
8. Signatures and Recommendations. (please date)
   • Signatures of involved Department chair(s) and Dean(s) indicate agreement with the proposal and that adequate resources (library, faculty, technology) are available to support proposal. If a potential signatory disagrees with a proposal he/she should write “I disagree with this proposal” and a signed statement should be attached to this submission.

   Thyagarajan Srinivasan / Chair, EE and Physics   Signature       Date
   3/11/14

   Jamal Ghorioshi / Chair, Mechanical Engineering and Engineering Management   Signature       Date
   Department chair(s) of all potentially affected programs
   3/11/14

   Dale Bruns / Dean, College of Science and Engineering   Signature       Date
   Dean(s) of any potentially affected College/School.
   3/10/14

   Susan Hritzak   Signature       Date
   Registrar
1. Course Title: Introduction to Weapons Systems

2. Course Number: EGR219
   Coordinate with Registrar to insure course number is available

3. Course Credit Hours:
   Classroom Hours 3 Lab Hours Other

4. Course Prerequisites: PHY 202 or other Physics 2 as corequisite. (It is assumed that this requires that the student has completed a Physics 1 course.)

5. Course Description (as proposed for the Bulletin): Course descriptions provide an overview of the topics covered. If the course is offered on a scheduled basis, i.e. every other year, or only during a set semester, note this in the description. Course descriptions should be no more than two to three sentences in length.

EGR 247. Introduction to Weapons Systems
THREE CREDITS
Introduction to military weapons and warfare, with a focus on how the modern period has resulted in greater complexity and the development of weapons systems. Basic principles of explosives, internal and exterior ballistics, calculation of probabilities of hit given randomness, fire control, guidance algorithms, radar and other sensors, detection and tracking, nuclear weapons and their effects. Corequisite: Phy202 or other Physics 2.

6. Required Documentation:
   Proposed Syllabus Attach proposed syllabus immediately after this document. In some situations the official syllabus may contain information which is beyond the review needs of the Curriculum Committee (such as extensive rubrics, etc). It is permissible to attach an abbreviated syllabus. In general, syllabi (whether full or abbreviated) should contain the following information: Course Title, Course Number, Credit hours, Faculty Information (name contact information, office hours), Course Description, Course Outcomes or Objectives, Assessment (grading) informations, required texts (or other things such as tools, software, etc), pertinent policies and a proposed schedule of topics.

Attached on following pages, adapted from syllabus of the most recent offering as a topics course.
EGR 219 Introduction to Weapons Systems (based on Spring, 2012 offering)


Scheduled class times: TBD
Instructor: John B. Gilmer Jr. Office hours: TBD Office: SLC220 Phone: x4885
Prerequisite: Physics 1, 2 (Can be taking Physics 2 at the same time. Doesn’t have to be 201/202)

Background:

Weapons are about as old as civilization. But with the industrial revolution and more recently the discovery of nuclear fission and now the mass use of computers, the nature of weapons have changed greatly. Weapons are no longer used in isolation by individuals, but in systems including target acquisition, control, and the weapons themselves, often with these components spread over an enormous area. This course will examine both the nature of the weapons themselves, including the engineering principles and physics. But it will also examine some of the other principles that are necessary for the weapon to be effective, including aiming (at moving targets), guidance, and sensing.

The course is going to focus on military weapons. Yes, weapons are also used for policing and hunting. But, the technical challenges of the military environment, and the variety of weapons used, is much greater and more complex. (Nobody uses nuclear weapons for hunting, and they are a bit expensive for crowd control.) The opportunities for jobs involving military weapons systems are much greater.

In the early days of weapons up to the 19th century, weapons were used by individuals (or a small crew for a cannon). Finding a target and aiming it, over a relatively short distance, was entirely manual. It was not “rocket science.” But with the development of longer range artillery, by the mid 19th century it became possible to fire at a target you could not see. Mortars and Howitzers were used during the American Civil War in this way for siege operations. This development required coordination, and organization. But it was the twentieth century that saw truly revolutionary developments.

One development was increasing range. By World War 1, naval guns and heavy siege weapons could fire a shell 15 miles or more. To hit a moving target with any chance of success, manual aiming was impractical. Early mechanical computers were developed, tied to range finders, corrections made for “spotting,” and a gyro stabilized reference plane. The “weapons system” had been invented. As the problem of engaging fast moving aircraft developed in World War 2, a high degree of automation in the use of weapons became necessary. Guided missiles moved some of that automation into the weapon itself in the second half of the 20th century. Modern small computers and GPS make it possible to, in effect, deliver a weapon to an address.

At the same time, from the 19th century through the 20th century, weapons were increasing in destructiveness. Mid 1800’s cannon fired shells, explosive projectiles, of up to about 100 pounds. By the early 20th century, large caliber shells weighed about a ton. Explosives and propellants were improving as well. By World War 2, aircraft were able to carry and drop several tons of bombs at a time. The British developed a 10 ton conventional bomb of enormous destructive power. The nuclear weapon increased the destructive power of weapons several orders of magnitude, to 20K tons (end of WW2) to about 20MTons (largest practical missile warhead).
The response to the increasing destructiveness of weapons was dispersal. In the 19th century, it was common for soldiers to march into battle and endure enemy fire side by side. Even against the early rifles of the day, this kind of fire could not be long endured. By the end of the War Between the States soldiers were fighting more dispersed, and taking cover in trenches and other field works. Throughout the 20th century, military formations on land, at sea, and in the air became more dispersed. This, in turn, made coordination more difficult, and weapons systems needed to cope with trying to hit dispersed, moving targets at long range.

The late 20th century and early 21st century have seen yet another revolution in weapons: the highly precise computer guided weapon. One reason nuclear weapons were attractive was that the sheer destructive power could overcome a lack of accuracy. Nuclear weapons were developed for use against aircraft, submarines, and surface ships for exactly this reason. A conventional weapon would have to hit to be disabling, but a nuclear weapon wouldn’t have to hit the target; anywhere close would do. But, with modern guidance, conventional weapons can hit targets. As a result, “tactical” nuclear weapons are disappearing. They are not really needed, and their employment is, shall we say, politically problematic. But, the use of modern precision weapons is extremely complex, and presents many engineering challenges. We will be particularly looking at these challenges in this course.

### Schedule:
A tentative schedule listing reading assignments and topics to be covered is listed below. The schedule is somewhat tentative with respect to the dates on which topics are covered.

<table>
<thead>
<tr>
<th>Week of</th>
<th>Topics covered</th>
<th>Reading, Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Weapons and war: trends and issues (overview)</td>
<td>supplement</td>
</tr>
<tr>
<td>2</td>
<td>Making a bang: explosives and destruction</td>
<td>Chapter 16,17,18</td>
</tr>
<tr>
<td>3</td>
<td>Getting it there: propulsion, rockets, and guns</td>
<td>Chapter 19</td>
</tr>
<tr>
<td>4</td>
<td>Personal weapons: Rifles, Pistols</td>
<td>Supplements</td>
</tr>
<tr>
<td>5</td>
<td>The guidance and aiming problem</td>
<td>Chapter 14</td>
</tr>
<tr>
<td>6</td>
<td>The biggest bang: Nuclear Weapons</td>
<td>Chapter 19</td>
</tr>
<tr>
<td>7</td>
<td>Finding the target: Radar and electromagnetics</td>
<td>Chapters 1-4</td>
</tr>
<tr>
<td>8</td>
<td>Tracking the target: controlling sensors</td>
<td>Chapter 5</td>
</tr>
<tr>
<td>9</td>
<td>Messing with the enemy’s sensors: electronic combat</td>
<td>Chapter 6</td>
</tr>
<tr>
<td>10</td>
<td>Electro-optic and other sensors</td>
<td>Chapters 7-8</td>
</tr>
<tr>
<td>11</td>
<td>Weapons control, overview</td>
<td>Chapter 12</td>
</tr>
<tr>
<td>12</td>
<td>Ballistics, fire control</td>
<td>Chapter 13</td>
</tr>
<tr>
<td>13</td>
<td>Guidance systems</td>
<td>Chapter 15</td>
</tr>
<tr>
<td>14</td>
<td>Recent developments and trends</td>
<td>Supplements</td>
</tr>
<tr>
<td>15</td>
<td>Exam</td>
<td>(comprehensive)</td>
</tr>
</tbody>
</table>

**About the text and readings:** The book being used for this course mentions in its title specifically “Naval” weapons. However, that is because the text was developed for a “Weapons 101” course at the U.S. Naval Academy. (It’s similar to the book used long ago when I took that course!) In fact, the principles covered in this book apply to military weapons in general. However, because of its origin, there is less emphasis on personal weapons and more on the larger ones. We need to supplement the text with some additional material with the second book, which is an encyclopedia of weapons. The Payne book also contains considerable material on electromagnetics and antennas that duplicate material found in other engineering courses. We will not cover this in
any more depth than necessary for our purposes. The book includes several chapters on underwater systems that we will also not cover. We are going to start with the simpler principles of explosives and propulsion rather than radar, so we are not reading the chapters in the original order.

The available edition of the book, in hard cover format from the U.S. Naval Institute, is fairly expensive, $60 or so. Earlier editions, some in paperback, may be found online. I cannot guarantee that these will be fully satisfactory; I have not seen them, and cannot compare them to the most recent edition.

Grading: Tests will cover all material through the previous week. Tests will generally be on the last day of the week listed, unless an announcement is made setting the date differently. Tests are open book. You will not have time to open your book very much, and still complete the test. Be well prepared. The exam will be comprehensive, but will have the major emphasis on the later topics.

There will be several homework assignments. The intent is to give you some practice on meaningful problems. Homework solutions will be reviewed at the beginning of the class when the assignments are due. These assignments will be ungraded, but I will take them up to see how students have done. After discussion there may be a pop quiz that covers some aspect of the homework material.

A research paper will be part of the course. Each student will research some particular weapon and make a formal report. Details will be developed later.

Grading Allocation:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 tests at 20% each</td>
<td>40%</td>
</tr>
<tr>
<td>class participation (do HW? attend?...)</td>
<td>4%</td>
</tr>
<tr>
<td>Final examination</td>
<td>35%</td>
</tr>
<tr>
<td>written report</td>
<td>15%</td>
</tr>
</tbody>
</table>

up to 3 pop quizzes, total of 6%

All material will be graded on a basis of 0-100, with most graded material allowing for grades higher than 100 with bonus questions (usually up to 10% extra) considered. On tests and the examinations some questions may be "compensated" if large numbers of students miss them (indicating possibly a badly posed question or inadequate coverage of the topic in class). On such questions, some proportion of the "lost" credit will be returned. This is the only form of "curving" of grades in the course. All written work is expected to be neat and well presented. A penalty of up to 10% will be assessed for poor presentation, and in extreme cases perhaps more.

The grades from all work will be weighted as given in the above table, totaled, and converted into the Wilkes 4.0 scale grading system using the following conversion:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Wilkes 4.0 Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>93+:</td>
<td>4.0</td>
</tr>
<tr>
<td>88-92:</td>
<td>3.5</td>
</tr>
<tr>
<td>70-76:</td>
<td>2.0</td>
</tr>
<tr>
<td>60-64:</td>
<td>1.0</td>
</tr>
<tr>
<td>below 60:</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Since the homework assignments are not graded, you may receive help on these or even work with another student. However, if you do this, please indicate the degree of your own involvement. If you simply submit a xerox copy of another student's work, explain your own role in doing the assignment, which should not be limited to just operating the copier. The degree to which students participate in doing homework will be subjectively judged and may influence the final grade by up to a point in either direction in borderline cases, as well as affecting the subjective "class
participation" part of the grade. The intent here is to allow any degree of cooperation and help on
the homework, and use the pop quiz as the grading mechanism to motivate doing homework. A pop
quiz is most likely to be given on the day that a homework assignment is due, or the following class.

Notes: I have notes for the course that will be available as reserve material in the library to students
who want to see them. I do not guarantee that my notes will match the lectures, since I do tend to
depart from prepared notes on occasion, and often skip topics that I decide not to cover in class due
to time limitations. A loose leaf notebook of these class notes will be kept in the library on reserve.
This will include some of the lecture materials or handouts used, worked homework assignments,
and test solutions. You are not obligated to copy any of this; it is merely meant to be helpful. Any
material that is really needed will be distributed in the form of handouts in class.