George Mason University
Graduate Course Approval/Inventory Form

Please complete this form and attach a copy of the syllabus for new courses. Forward it as an email attachment to the Secretary of the Graduate Council. A printed copy of the form with signatures should be brought to the Graduate Council Meeting. Complete the Coordinator Form on page 2, if changes in this course will affect other units.

Please indicate:  ____X__ NEW  ____MODIFY  ____DELETE

Local Unit: ECE/TCOM  Graduate Council Approval Date:

Course Abbreviation: TCOM  Course Number: 526

Full Course Title: Advanced Global Positioning System

Abbreviated Course Title (24 characters max.): Advanced GPS

Credit hours: 1.5  Program of Record: MS in Telecommunications

Repeatable for Credit?  ____ D=Yes, not within same term  Up to hours
 ____ T=Yes, within the same term  Up to hours
 ____ N=Cannot be repeated for credit

Activity Code (please indicate):  __X__ Lecture (LEC)  ____ Lab (LAB)  ____ Recitation (RCT)
 ____ Studio (STU)  ____ Internship (INT)  ____ Independent Study (IND)
 ____ Seminar (SEM)

Catalog Credit Format  1.5: 1.5: 0  Course Level: GF(500-600)  ____X__ GA(700+)

Maximum Enrollment: 42  For NEW courses, first term to be offered: Fall 2005

Prerequisites or co-requisites: prerequisite course TCOM 516

Catalog Description (35 words or less) Please use catalog format and attach a copy of the syllabus for new courses: Advanced global navigation satellite systems, such as the US GPS, the European Galileo, and the Russian GLONASS. System description; design of wide area augmentation system (WAAS in US, EGNOS in Europe, and MSAS in Japan).

For MODIFIED or DELETED courses as appropriate:
Last term offered:  Previous Course Abbreviation:  Previous number:

Description of modification:

APPROVAL SIGNATURES:
Submitted by:  ____Jeremy Allnutt_____________ email: jallnutt@gmu.edu

Department/Program:  ___ECE/MS in Telecommunications  ___ Date: __Oct. 18th, 2004__

College Committee:  _______________________________ Date: __Oct. 21st, 2004__

Graduate Council Representative:  _______________________________ Date: __________________
GEORGE MASON UNIVERSITY  
Course Coordination Form  

Approval from other units: Not applicable  
Please list those units outside of your own who may be affected by this new, modified, or deleted course. Each of these units must approve this change prior to its being submitted to the Graduate Council for approval.

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Graduate Council approval: ____________________________ Date: __________
Graduate Council representative: ____________________________ Date: __________
Provost Office representative: ____________________________ Date: __________
SCHOOL PROPOSAL TO THE GRADUATE COUNCIL
BY
SCHOOL OF INFORMATION TECHNOLOGY AND ENGINEERING

1. CATALOG DESCRIPTION
   (a) TCOM 526 Advanced Global Positioning System (GPS) (1.5:1.5:0)
   (b) Prerequisites: TCOM 516
   (c) Catalog Description: Advanced concepts in global navigation satellite systems (GNSS) such as
       the American GPS (global positioning system), the European’s Galileo and the Russian’s
       GLONASS (GLObal NAvigation Satellite System). System level description, architecture and
       design of a wide area augmentation system (WAAS) comprising geostationary satellites
       overlaying GPS satellites and its vast network of monitoring and control ground stations. The
       equivalent EGNOS (European Geostationary Navigation Overlay Service), a precursor to Galileo
       and the Japanese MSAS (Multi-transport Satellite-based Augmentation System). Updates on
       evolving GNSS technology and GNSS backup alternatives.

2. JUSTIFICATION
   (a) Course Objectives
       This advanced GPS course builds on the basic GPS course TCOM 516 to provide students with
       in-depth knowledge on the architecture and design of the WAAS at the system level and its
       integration to the overall GPS architecture. Students will gain an appreciation for how the
       WAAS system operates, the format and generation of the WAAS signals, and how data is
       processed to determine the integrity, differential corrections and residual errors for each
       monitored geostationary satellite providing WAAS. Design features of the WAAS to provide a
       system availability of 99.95% will be reviewed. Students will also gain knowledge of emerging
       new systems, in particular, the European Galileo system and Russia’s upgrade to GLONASS.

   (b) Course Necessity
       The current 1.5 credit hour course on GPS, TCOM 516, is of insufficient length to provide
       students with more in-depth information on the global positioning system, its augmentation
       (WAAS), for which the initial operational phase was commissioned in July 2003 and the final
       operational phase is scheduled for 2006, and the Galileo global navigation satellite system,
       which is in its initial implementation phase. Rather than develop a 3.0 credit hour course on
       GPS, it was felt that a second 1.5 credit hour course on advanced GPS would be the most
       appropriate way to augment the basic GPS course, thus the TCOM 516/526 combination of 1.5
       credit hour courses would together provide a semester length course on global navigation satellite
       systems. GPS, and like systems, are becoming an integral part of mobile communications as
       well as the basis for precise navigation on the surface of the earth and all regions above the
       surface of the earth, including near-earth space. This course will allow students to build on the
       knowledge gained from the basic GPS course, TCOM 516, and make them fully cognizant of the
       rapidly evolving technology on global navigation satellite systems.

   (c) Relationship to Existing Courses
       The course is a natural progression for students to take following the basic GPS course, TCOM
       516. Timing and related telecommunications background required for this course would be
       obtained through TCOM 500, 501, and 502, and TCOM 516 will prepare students for the
       advanced concepts dealt with in TCOM 526. No course matches the proposed course in its
       detailed content, although there are elements of satellite communications (TCOM 607) that may
       be briefly reviewed in this course.
3. APPROVAL HISTORY

ECE Department Date: October 18th, 2004

IT&E Graduate Committee Date: October 21st, 2004

IT&E Dean Date:

4. SCHEDULING
Every fall semester, starting fall 2005, to be paired with TCOM 516. Proposed instructors are Dr. Jeremy Allnutt, Dr. Grace Pazos, and suitably qualified faculty members and adjunct professors from commercial or government related companies and agencies.

5. COURSE OUTLINE
(a) Syllabus

Week 1
Geosynchronous WAAS satellites and GPS satellites; Wide Area Augmentation System (WAAS) GPS payload – design and implementation; link budgets; spread spectrum CDMA transmission mode, triangulation basics - ranging and timing errors

Week 2
GPS Sources of errors: ephemeris; ionospheric and tropospheric delays; multipath; receiver noise and clock bias; satellite clock bias; relativistic effects; Doppler shift; dilution of precision; selective availability; spoofing

Weeks 3
Wide Area Augmentation System (WAAS)
Description of the Federal Aviation Administration’s WAAS system – architecture, design, operational and support environments.
a. WAAS network – description of system components and redundancy
b. WAAS functional block diagram
c. WAAS signal and message flow
d. WAAS Ground Uplink subsystem

Weeks 4
Wide Area Augmentation System (WAAS) – continued
e. WAAS terrestrial network and router
f. WAAS radio frequency subsystem
   • C-band, L-band and omni antennas
   • Low noise amplifiers
   • Solid state power amplifiers
   • Frequency converters
   • Test loop translator

Weeks 5
Wide Area Augmentation System (WAAS) – continued
Week 6
GPS backup system, receiver types, applications and measurement techniques
Enhanced Loran C; GPS receiver types; GPS equipment calibration; geographic information system; Network Time Protocol (NTP) – internet time transfer; geo-stationary satellite time and frequency dissemination; GPS measurement techniques in time & frequency metrology

Week 7
Differential GPS (DGPS); Galileo GNSS (system configuration, comparison with GPS); benefits on the combined use of the European Galileo and the U.S. GPS. Updates on Galileo, GLONASS (Russia’s GNSS) and WAAS status. Comparison of the three inter-regional Satellite-based Augmentation Services (SBAS) that complement the GPS and GLONASS: EGNOS (European Geostationary Navigation Overlay Services), American WAAS, and the Japanese MSAS (Multi-transport Satellite-based Augmentation Service).