**Sana'a University**
**Faculty of Engineering**
**Department: Electrical Engineering**
**Title of the Program: Communication Engineering and Networks**

# Course Specification of Satellite Communications and RADAR Systems

## I. Course Identification and General Information:

| | | | | | | |
|---|---|---|---|---|---|---|
| **1.** | Course Title: | Satellite Communications and RADAR Systems | | | | |
| **2.** | Course Code & Number: | CNE331 | | | | |
| **3.** | Credit hours: | C.H | | | | TOTAL |
| | | Th. | Tu. | Pr. | Tr. | |
| | | 2 | 2 | - | - | 3 |
| **4.** | Study level/ semester at which this course is offered: | 4th Year - 1st Semester | | | | |
| **5.** | Pre –requisite (if any): | Linear Algebra (BR121), Engineering Mathematics (BR223), Signals and Systems (CNE214), Communications Principles (CNE221), Digital Communications (CNE323) & Wave Propagation and Antennas (CNE323) | | | | |
| **6.** | Co –requisite (if any): | None | | | | |
| **7.** | Program (s) in which the course is offered: | Communication Engineering and Network | | | | |
| **8.** | Language of teaching the course: | English | | | | |
| **9.** | Location of teaching the course: | Faculty of Engineering - Electrical Department | | | | |
| **10.** | Prepared By: | Dr. Mohammed Abdul Karim Al-Suraby | | | | |
| **11.** | Date of Approval | May 2020 | | | | |

## II. Course Description:

This course is developed to provide principal concepts of satellite communications and RADAR systems. This course will cover the most relevant aspects of satellite communications and RADAR systems, with emphasis on the most recent applications and developments. It includes low earth orbit and geostationary

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satellite systems; transmission systems; RF link budgets; modulation and multiplexing; multiple access techniques, satellite transponders, antennas, and earth stations. This course discusses the fundamental principles behing the design and operation of RADAR systems for different applications.

| **III. Course Intended learning outcomes (CILOs) of the course** | | **Referenced PILOs** |
|---|---|---|
| **a1** | Recognize the principles of satellite communications including topics of orbits, satellite space segment, and propagation and satellite links. | A1 and A2 |
| **a2** | Understand the complete RADAR range equation, listing out all the losses to be accounted for. | A1 and A2 |
| **b1** | Demonstrate the design of satellite links for specified C/N with system design examples. | B1 |
| **b2** | Analyze the range parameters of pulse RADAR system which affect the system performance. | B2 and B3 |
| **c1** | Compute the satellite link parameters under various propagation conditions with the illustration of multiple access techniques. | C1 and C4 |
| **c2** | Use the radar equation to solve problems related to detecting targets and finding the distance to their locations | C1, C2 and C4 |
| **d1** | Being able to work in an interdisciplinary team, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available | D1 |
| **d2** | Use effectively of information resources. | D5 |

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| **(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:** | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **a1 -** Recognize the principles of satellite communications including topics of orbits, satellite space segment, and propagation and satellite links. | ▪ Active lectures,<br>▪ Interactive class discussions<br>▪ Tutorials | ▪ Home works,<br>▪ Assignments,<br>▪ Quizzes<br>▪ Written Exam |
| **a2 -** Understand the complete RADAR range equation, listing out all the losses to be accounted for. | ▪ Active lectures,<br>▪ Interactive class discussions<br>▪ Tutorials | ▪ Home works,<br>▪ Assignments,<br>▪ Quizzes<br>▪ Written Exam |

| **(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:** | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **b1 -** Demonstrate the design of satellite links for specified C/N with system design examples. | ▪ Active lectures,<br>▪ Interactive class discussions,<br>▪ Tutorials<br>▪ Exercises | ▪ Home works<br>▪ Assignments |
| **b2 -** Analyze the range parameters of pulse RADAR system which affect the system performance. | ▪ Active lectures,<br>▪ Interactive class discussions,<br>▪ Tutorials<br>▪ Exercises | ▪ Home works<br>▪ Assignments |

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| **© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:** | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **c1 -** Compute the satellite link parameters under various propagation conditions with the illustration of multiple access techniques. | ▪ Active lectures,<br>▪ Interactive class discussions,<br>▪ Tutorials<br>▪ Exercises | ▪ Home works<br>▪ Assignments |
| **c2 -** Use the radar equation to solve problems related to detecting targets and finding the distance to their locations. | ▪ Active lectures,<br>▪ Interactive class discussions,<br>▪ Tutorials<br>▪ Exercises | ▪ Home works<br>▪ Assignments |

| **(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:** | | |
|---|---|---|
| Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **d1 -** Being able to work in an interdisciplinary team, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available. | ▪ Tutorials<br>▪ Exercises | ▪ Home works<br>▪ Assignments. |
| **d2 -** Use effectively of information resources. | ▪ Tutorials<br>▪ Exercises | ▪ Home works<br>▪ Assignments. |

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## IV. Course Content:

### A – Theoretical Aspect:

| Order | Units/Topics List | Learning Outcomes | Sub Topics List | Number of Weeks | Contact hours |
|---|---|---|---|---|---|
| **1.** | An Introduction to Satellite Communications | a1, d1 and d2. | ▪ Origin of Satellite Communications.<br>▪ Historical Back-ground, Basic Concepts of Satellite Communications.<br>▪ Frequency Allocations for Satellite Services, Applications. | 2 | 4 |
| **2.** | Orbital Mechanics and Launchers | a1, d1 and d2. | ▪ Orbital Mechanics, Look Angle determination, Orbital Perturbations.<br>▪ Orbit determination, Orbital Effects in Communication Systems Performance. | 2 | 4 |
| **3.** | Satellite Link Design | a1, b1, c1,d1 and d2. | ▪ Basic Transmission Theory.<br>▪ System Noise Temperature and G/T Ratio.<br>▪ Design of Down Links, Up Link Design, System Design Examples. | 2 | 4 |
| **4.** | Multiple Access | a1, c1, d1 and d2. | ▪ Frequency Division Multiple Access (FDMA), Intermodulation, Calculation of C/N.<br>▪ Time Division Multiple Access (TDMA), Frame Structure, Examples.<br>▪ Code Division Multiple Access (CDMA), Spread Spectrum Transmission and Reception. | 2 | 4 |

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| | | | | | |
|---|---|---|---|---|---|
| **5.** | Basics of Radar | a2, b2, c2, d1 and d2. | ▪ Nature of RADAR.<br>▪ Maximum Unambiguous range, Radar Waveforms.<br>▪ RADAR block diagram and operation.<br>▪ RADAR frequencies, Applications of RADARs. | 2 | 4 |
| **6.** | Radar Equation | a2, b2, c2, d1 and d2. | ▪ Prediction of Range Performance.<br>▪ Minimum Detectable Signal, Receiver Noise and SNR.<br>▪ Integration of Radar Pulses, Radar Cross Section of Targets.<br>▪ Transmitter Power, PRF and Range Ambiguities.<br>▪ System Losses. | 2 | 4 |
| **7.** | Radar Types | a2, b2, c2, d1 and d2. | ▪ Pulse radars and CW RADARs, Advantages of coherent radar.<br>▪ Doppler radar and MTI.<br>▪ Tracking RADAR. | 2 | 4 |
| **Number of Weeks /and Units Per Semester** | | | | **14** | **28** |

## B - Tutorial Aspect:

| Order | Tutorial Skills List | Number of Weeks | Contact Hours | Learning Outcomes |
|---|---|---|---|---|
| **1.** | An Introduction to Satellite Communications<br>• Origin of Satellite Communications.<br>• Historical Back-ground, Basic Concepts of Satellite Communications. | 2 | 4 | a1, d1 and d2. |

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| | | | | |
|---|---|---|---|---|
| | • Frequency Allocations for Satellite Services, Applications. | | | |
| **2.** | Orbital Mechanics and Launchers<br>• Orbital Mechanics, Look Angle determination, Orbital Perturbations.<br>• Orbit determination, Orbital Effects in Communication Systems Performance. | 2 | 4 | a1, d1 and d2. |
| **3.** | Satellite Link Design<br>• Basic Transmission Theory.<br>• System Noise Temperature and G/T Ratio.<br>• Design of Down Links, Up Link Design, System Design, Examples. | 2 | 4 | a1, b1, c1, d1 and d2. |
| **4.** | Multiple Access<br>• Frequency Division Multiple Access (FDMA), Intermodulation, Calculation of C/N.<br>• Time Division Multiple Access (TDMA), Frame Structure, Examples.<br>• Code Division Multiple Access (CDMA), Spread Spectrum Transmission and Reception. | 2 | 4 | a1, c1, d1 and d2. |
| **5.** | Basics of Radar<br>• Nature of RADAR.<br>• Maximum Unambiguous range, Radar Waveforms.<br>• RADAR block diagram and operation.<br>• RADAR frequencies, Applications of RADARs. | 2 | 4 | a2, b2, c2, d1 and d2. |
| **6.** | Radar Equation<br>• Prediction of Range Performance.<br>• Minimum Detectable Signal, Receiver Noise and SNR. | 2 | 4 | a2, b2, c2, d1 and d2. |

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| | | | | |
|---|---|---|---|---|
| | • Integration of Radar Pulses, Radar Cross Section of Targets.<br>• Transmitter Power, PRF and Range Ambiguities.<br>• System Losses. | | | |
| **7.** | Radar Types<br>• Pulse radars and CW RADARs, Advantages of coherent radar.<br>• Doppler radar and MTI.<br>• Tracking RADAR. | 2 | 4 | a2, b2, c2, d1 and d2. |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** | |

## V. Teaching strategies of the course:

- Active Lectures.
- Interactive class discussions.
- Tutorials.
- Exercises and Home works.

## VI. Assignments:

| No | Assignments | Aligned CILOs(symbols) | Week Due | Mark |
|---|---|---|---|---|
| **1.** | An Introduction to Satellite Communications<br>▪ Origin of Satellite Communications.<br>▪ Historical Back-ground, Basic Concepts of Satellite Communications.<br>▪ Frequency Allocations for Satellite Services, Applications. | a1, d1 and d2. | 1st and 2nd | 1.5 |
| **2.** | Orbital Mechanics and Launchers<br>▪ Orbital Mechanics, Look Angle determination, Orbital | a1, d1 and d2. | 3th and 4th | 1.5 |

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| | | | | |
|---|---|---|---|---|
| | Perturbations.<br>▪ Orbit determination, Orbital Effects in Communication Systems Performance. | | | |
| **3.** | Satellite Link Design<br>▪ Basic Transmission Theory.<br>▪ System Noise Temperature and G/T Ratio.<br>▪ Design of Down Links, Up Link Design, System Design, Examples. | a1, b1, c1, d1 and d2. | 5th and 6th | 3 |
| **4.** | Multiple Access<br>▪ Frequency Division Multiple Access (FDMA), Intermodulation, Calculation of C/N.<br>▪ Time Division Multiple Access (TDMA), Frame Structure,<br>Examples.<br>▪ Code Division Multiple Access (CDMA), Spread Spectrum<br>Transmission and Reception. | a1, c1, d1 and d2. | 7th and 8th | 1.5 |
| **5.** | Basics of RADAR<br>▪ Nature of RADAR.<br>▪ Maximum Unambiguous range, RADAR Waveforms.<br>▪ RADAR block diagram and operation.<br>▪ RADAR frequencies, Applications of RADARs. | a2, b2, c2, d1 and d2. | 10th | 1.5 |
| **6.** | RADAR Equation<br>▪ Prediction of Range Performance.<br>▪ Minimum Detectable Signal, Receiver Noise and SNR.<br>▪ Integration of RADAR Pulses, RADAR Cross Section of Targets.<br>▪ Transmitter Power, PRF and Range Ambiguities.<br>▪ System Losses. | a2, b2, c2, d1 and d2. | 11th and 12th | 3 |

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| | | | | |
|---|---|---|---|---|
| **7.** | RADAR Types<br>▪ Pulse RADARs and CW RADARs, Advantages of coherent RADAR.<br>▪ Doppler RADAR and MTI.<br>▪ Tracking RADAR. | a2, b2, c2, d1 and d2. | 13th and 14th | 3 |
| | **Total** | | | **15** |

## VII. Schedule of Assessment Tasks for Students During the Semester:

| No. | Assessment Method | Week Due | Mark | Proportion of Final Assessment | Aligned Course Learning Outcomes |
|---|---|---|---|---|---|
| **1.** | Home works and Assignments | Weekly | 15 | 10% | a1, a2, b1, b2, c1, c2, d1 and d2 |
| **2.** | Quizzes | 4th, 8th, 11th and 13th | 15 | 10% | a1, a2, b1, b2, c1 and c2 |
| **3.** | Med -Term Exam | 9th | 30 | 20% | a1, b1 and c1 |
| **4.** | Final Exam | 16th | 90 | 60% | a1, a2, b1, b2, c1 and c2 |
| | **Total** | | **150** | **100%** | |

## VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

**1- Required Textbook(s) (maximum two ).**

1- Dennis Roddy (2006), Satellite Communications – 4th Edition, U.S.A, McGraw Hill.
2- Merrill I. Skolnik (2001), Introduction to RADAR Systems - 3th Edition, Singapore, McGraw Hill.

**2- Essential References.**

1- M. Richharia (1995), Satellite Communications Systems, Design Principles, 2nd Edition, London, Macmillan Press LTD.
2- Merrill I. Skolnik (2008), RADAR Handbook – 3th Edition, U.S.A, McGraw Hill.

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| 3- Electronic Materials and Web Sites *etc*. | |
|---|---|
| | 1- http://advancedengineering.umd.edu/node/2320<br>2- http://ece564web.groups.et.byu.net<br>3- http://personal.stevens.edu/~yyao/syllabus-674.html |

## IX. Course Policies:

| | |
|---|---|
| **1.** | **Class Attendance:**<br>A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic |
| **2.** | **Tardy:**<br>For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent. |
| **3.** | **Exam Attendance/Punctuality:**<br>A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam- |
| **4.** | **Assignments & Projects:**<br>The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time- |
| **5.** | **Cheating:**<br>For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty- |
| **6.** | **Plagiarism**:<br>Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university. |
| **7.** | **Other policies:** |

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|---|---|
| | - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room<br>- Mobile phones are not allowed in class during the examination.<br>Lecture notes and assignments my given directly to students using soft or hard copy |

| | |
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| **Reviewed By** | **Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat**<br>**President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi**<br>**Name of Reviewer from the Department: Asst. Prof. Dr. Adel Ahmed Al-Shakiri** |
| | **Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa**<br>**Assoc. Prof. Dr. Ahmed Mujahed**<br>**Asst. Prof. Dr. Munasar Alsubri** |

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**Sana'a University**
**Faculty of Engineering**
**Department: Electrical Engineering**
**Title of the Program: Communication Engineering and Networks**

# Template for Course Plan of Satellite Communications and RADAR Systems

| I. - Information about Faculty Member Responsible for the Course: | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Name of Faculty Member** | Dr. Mohammed Al-Suraby | **Office Hours** | | | | | |
| **Location& Telephone No.** | Department of Electrical Engineering: + 967 773351310 | **SAT** | **SUN** | **MON** | **TUE** | **WED** | **THU** |
| **E-mail** | makas2018@gmail.com | | | | | | |

| II. Course Identification and General Information: | | | | | | |
|---|---|---|---|---|---|---|
| **1-** | Course Title: | Satellite Communications and RADAR Systems | | | | |
| **2-** | Course Number & Code: | CNE331 | | | | |
| **3-** | Credit hours: | C.H | | | | Total |
| | | Th. | Tu. | Pr. | Tr. | |
| | | 2 | 2 | - | - | 3 |
| **4-** | Study level/year at which this course is offered: | 5th Year - 1st Semester | | | | |
| **5-** | Pre –requisite (if any): | Linear Algebra (BR121), Engineering Mathematics (BR223), Signals and Systems (CNE214), Communications Principles (CNE221), Digital Communications (CNE323) & Wave Propagation and Antennas (CNE323) | | | | |
| **6-** | Co –requisite (if any): | None | | | | |
| **7-** | Program (s) in which the course is offered | Communication Engineering and Networks | | | | |
| **8-** | Language of teaching the course: | English | | | | |
| **9-** | System of Study: | Semester | | | | |

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|---|---|---|
| **10-** | Mode of delivery: | |
| **11-** | Location of teaching the course: | Faculty of Engineering - Electrical Department |

## III. Course Description:

This course is developed to provide principal concepts of satellite communications and RADAR systems. This course will cover the most relevant aspects of satellite communications and RADAR systems, with emphasis on the most recent applications and developments. It includes low earth orbit and geostationary satellite systems; transmission systems; RF link budgets; modulation and multiplexing; multiple access techniques, satellite transponders, antennas, and earth stations. This course discusses the fundamental principles behing the design and operation of RADAR systems for different applications.

## IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. Recognize the principles of satellite communications including topics of orbits, satellite space segment, and propagation and satellite links.
2. Understand the complete RADAR range equation, listing out all the losses to be accounted for.
3. Demonstrate the design of satellite links for specified C/N with system design examples.
4. Analyze the range parameters of pulse RADAR system which affect the system performance.
5. Compute the satellite link parameters under various propagation conditions with the illustration of multiple access techniques.
6. Use the radar equation to solve problems related to detecting targets and finding the distance to their locations
7. Being able to work in an interdisciplinary team, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available
8. Use effectively of information resources.

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## V. Course Content:

### A – Theoretical Aspect:

| Order | Units/Topics List | Sub Topics List | Number of Weeks | Contact hours |
|---|---|---|---|---|
| **1.** | An Introduction to Satellite Communications | ▪ Origin of Satellite Communications.<br>▪ Historical Back-ground, Basic Concepts of Satellite Communications.<br>▪ Frequency Allocations for Satellite Services, Applications. | 1st ,2nd | 4 |
| **2.** | Orbital Mechanics and Launchers | ▪ Orbital Mechanics, Look Angle determination, Orbital Perturbations.<br>▪ Orbit determination, Orbital Effects in Communication Systems Performance. | 3rd ,4th | 4 |
| **3.** | Satellite Link Design | ▪ Basic Transmission Theory.<br>▪ System Noise Temperature and G/T Ratio.<br>▪ Design of Down Links, Up Link Design, System Design Examples. | 5th ,6th | 4 |
| **4.** | Multiple Access | ▪ Frequency Division Multiple Access (FDMA), Intermodulation, Calculation of C/N.<br>▪ Time Division Multiple Access (TDMA), Frame Structure, Examples.<br>▪ Code Division Multiple Access (CDMA), Spread Spectrum Transmission and Reception. | 7th ,8th | 4 |
| **5.** | Med-Term Exam | ▪ From order1 to order4 | 9th | 2 |
| **6.** | Basics of Radar | ▪ Nature of RADAR. | 10th ,11th | 4 |

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| | | | | |
|---|---|---|---|---|
| | | ▪ Maximum Unambiguous range, Radar Waveforms.<br>▪ RADAR block diagram and operation.<br>▪ RADAR frequencies, Applications of RADARs. | | |
| **7.** | Radar Equation | ▪ Prediction of Range Performance.<br>▪ Minimum Detectable Signal, Receiver Noise and SNR.<br>▪ Integration of Radar Pulses, Radar Cross Section of Targets.<br>▪ Transmitter Power, PRF and Range Ambiguities.<br>▪ System Losses. | $12^{th}$ ,$13^{th}$ | 4 |
| **8.** | Radar Types | ▪ Pulse radars and CW RADARs, Advantages of coherent radar.<br>▪ Doppler radar and MTI.<br>▪ Tracking RADAR. | $14^{th}$ ,$15^{th}$ | 4 |
| **9.** | Final Exam | ▪ All Topics | $16^{th}$ | 2 |
| **Number of Weeks /and Units Per Semester** | | | **32** | **16** |

## B - Tutorial Aspect:

| Order | Tutorial Skills List | Number of Weeks | Contact Hours |
|---|---|---|---|
| **1.** | An Introduction to Satellite Communications<br>• Origin of Satellite Communications.<br>• Historical Back-ground, Basic Concepts of Satellite Communications.<br>• Frequency Allocations for Satellite Services, Applications. | **$1^{st}$ ,$2^{nd}$** | 4 |

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|---|---|---|---|
| **2.** | Orbital Mechanics and Launchers<br>• Orbital Mechanics, Look Angle determination, Orbital Perturbations.<br>• Orbit determination, Orbital Effects in Communication Systems Performance. | 3rd ,4th | 4 |
| **3.** | Satellite Link Design<br>• Basic Transmission Theory.<br>• System Noise Temperature and G/T Ratio.<br>• Design of Down Links, Up Link Design, System Design, Examples. | 5th ,6th | 4 |
| **4.** | Multiple Access<br>• Frequency Division Multiple Access (FDMA), Intermodulation, Calculation of C/N.<br>• Time Division Multiple Access (TDMA), Frame Structure, Examples.<br>• Code Division Multiple Access (CDMA), Spread Spectrum Transmission and Reception. | 7th ,8th | 4 |
| **5.** | Basics of Radar<br>• Nature of RADAR.<br>• Maximum Unambiguous range, Radar Waveforms.<br>• RADAR block diagram and operation.<br>• RADAR frequencies, Applications of RADARs. | 9th ,10th | 4 |
| **6.** | Radar Equation<br>• Prediction of Range Performance.<br>• Minimum Detectable Signal, Receiver Noise and SNR.<br>• Integration of Radar Pulses, Radar Cross Section of Targets.<br>• Transmitter Power, PRF and Range Ambiguities.<br>• System Losses. | 11th ,12th | 4 |

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| **7.** | Radar Types<br>• Pulse radars and CW RADARs, Advantages of coherent radar.<br>• Doppler radar and MTI.<br>• Tracking RADAR. | 13th ,14th | 4 |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** |

## VI. Teaching strategies of the course:

- Active Lectures.
- Interactive class discussions.
- Tutorials.
- Exercises and Home works.

## VII. Assignments:

| No | Assignments | Aligned CILOs(symbols) | Week Due | Mark |
|---|---|---|---|---|
| **1.** | An Introduction to Satellite Communications<br>▪ Origin of Satellite Communications.<br>▪ Historical Back-ground, Basic Concepts of Satellite Communications.<br>▪ Frequency Allocations for Satellite Services, Applications. | a1, d1 and d2. | 1st and 2nd | 1.5 |
| **2.** | Orbital Mechanics and Launchers<br>▪ Orbital Mechanics, Look Angle determination, Orbital Perturbations.<br>▪ Orbit determination, Orbital Effects in Communication Systems Performance. | a1, d1 and d2. | 3th and 4th | 1.5 |
| **3.** | Satellite Link Design<br>▪ Basic Transmission Theory.<br>▪ System Noise Temperature and G/T Ratio. | a1, b1, c1, d1 and d2. | 5th and 6th | 3 |

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| | | | | |
|---|---|---|---|---|
| | ▪ Design of Down Links, Up Link Design, System Design, Examples. | | | |
| **4.** | Multiple Access<br>▪ Frequency Division Multiple Access (FDMA), Intermodulation, Calculation of C/N.<br>▪ Time Division Multiple Access (TDMA), Frame Structure,<br>Examples.<br>▪ Code Division Multiple Access (CDMA), Spread Spectrum<br>Transmission and Reception. | a1, c1, d1 and d2. | 7th and 8th | 1.5 |
| **5.** | Basics of RADAR<br>▪ Nature of RADAR.<br>▪ Maximum Unambiguous range, RADAR Waveforms.<br>▪ RADAR block diagram and operation.<br>▪ RADAR frequencies, Applications of RADARs. | a2, b2, c2, d1 and d2. | 10th | 1.5 |
| **6.** | RADAR Equation<br>▪ Prediction of Range Performance.<br>▪ Minimum Detectable Signal, Receiver Noise and SNR.<br>▪ Integration of RADAR Pulses, RADAR Cross Section of Targets.<br>▪ Transmitter Power, PRF and Range Ambiguities.<br>▪ System Losses. | a2, b2, c2, d1 and d2. | 11th and 12th | 3 |
| **7.** | RADAR Types<br>▪ Pulse RADARs and CW RADARs, Advantages of coherent RADAR.<br>▪ Doppler RADAR and MTI.<br>▪ Tracking RADAR. | a2, b2, c2, d1 and d2. | 13th and 14th | 3 |
| | **Total** | | | **15** |

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## VIII. Schedule of Assessment Tasks for Students During the Semester:

| No. | Assessment Method | Week Due | Mark | Proportion of Final Assessment |
|---|---|---|---|---|
| **1.** | Home works and Assignments | Weekly | 15 | 10% |
| **2.** | Quizzes | 4th, 8th, 11th and 13th | 15 | 10% |
| **3.** | Med -Term Exam | 9th | 30 | 20% |
| **4.** | Final Exam | 16th | 90 | 60% |
| | **Total** | | **150** | **100%** |

## IX. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

**1- Required Textbook(s) (maximum two ).**

1. Dennis Roddy (2006), Satellite Communications – 4th Edition, U.S.A, McGraw Hill.
2. Merrill I. Skolnik (2001), Introduction to RADAR Systems - 3th Edition, Singapore, McGraw Hill.

**2- Essential References.**

1. M. Richharia (1995), Satellite Communications Systems, Design Principles, 2nd Edition, London, Macmillan Press LTD.
2. Merrill I. Skolnik (2008), RADAR Handbook – 3th Edition, U.S.A, McGraw Hill.

**3- Electronic Materials and Web Sites *etc*.**

1. http://advancedengineering.umd.edu/node/2320
2. http://ece564web.groups.et.byu.net
3. http://personal.stevens.edu/~yyao/syllabus-674.html

## X. Course Policies:

**1. Class Attendance:**

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| | A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic |
| **2.** | **Tardy:**<br>For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent. |
| **3.** | **Exam Attendance/Punctuality:**<br>A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam- |
| **4.** | **Assignments & Projects:**<br>The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time- |
| **5.** | **Cheating:**<br>For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty- |
| **6.** | **Plagiarism**:<br>Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university. |
| **7.** | **Other policies:**<br>- Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room<br>- Mobile phones are not allowed in class during the examination.<br>Lecture notes and assignments my given directly to students using soft or hard copy |

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