



MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

| Module Information | | | | |
|------------------------------------|-----------------------|-------------------------------|---|--|
| معلومات المادة الدراسية | | | | |
| Module Title | Refrigeration Systems | | Module Delivery | |
| Module Type | Core | | <input checked="" type="checkbox"/> Theory <input type="checkbox"/> Lecture <input checked="" type="checkbox"/> Lab <input checked="" type="checkbox"/> Tutorial <input type="checkbox"/> Practical <input type="checkbox"/> Seminar | |
| Module Code | RAC 401 | | | |
| ECTS Credits | 7 | | | |
| SWL (hr/sem) | 175 | | | |
| Module Level | Four | Semester of Deliver | | Seven |
| Administering Department | PM | College | TEMO | |
| Module Leader | Hareth Maher Abd | | e-mail | harethmaher@ntu.edu.iq |
| Module Leader's Acad. Title | Assist. Prof. | Module Leader's Qualification | M.Sc. | |
| Module Tutor | Name (if available) | | e-mail | E-mail |
| Peer Reviewer Name | Name | | e-mail | E-mail |
| Scientific Committee Approval Date | 01/6/2023 | Version Number | 1.0 | |

| Relation with other Modules | | | | |
|-----------------------------------|------|--|----------|--|
| العلاقة مع المواد الدراسية الأخرى | | | | |
| Prerequisite module | None | | Semester | |
| Co-requisites module | None | | Semester | |

Module Aims, Learning Outcomes and Indicative Contents

أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية

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|--|---|
| Module Objectives أهداف المادة الدراسية | <ol style="list-style-type: none"> 1. To enhance the student's knowledge of the various refrigeration systems. 2. To understand the working principle of various refrigeration systems. 3. Understanding how to choose the best refrigeration system for each application. 4. To emphasize the students' understanding of the fundamentals and analyses of refrigeration systems that use vapor compression. 5. To be able to compute the overall heat transfer coefficients, heat transfer, and pressure drop for the fluid flow in heat exchanger tubes and shells. 6. To emphasize the students' knowledge of the analysis and calculation of various refrigeration systems. 7. To comprehend the liquefaction of gasses and cryogenic refrigeration |
| Module Learning Outcomes مخرجات التعلم للمادة الدراسية | <p>Important: Write at least 6 Learning Outcomes, better to be equal to the number of study weeks.</p> <ol style="list-style-type: none"> 1. Recognize how the air refrigeration system works and how it can compute its performance. 2. Discuss the absorption refrigeration systems' work and analyses. 3. To emphasize the students' knowledge of the principles and analysis of steam jet refrigeration. 4. Describe the components of the heat pipe and illustrate how it works. 5. Describe the components of the Vortex tube and illustrate how it works. 6. Recognize how the performance of each component is influenced by other components when change is occur in the operation condition 7. Identify the correct use of materials and equipment components in the various systems. 8. Evaluate the amount of liquefied air mass ratio under different methods of the cooling system. |
| Indicative Contents المحتويات الإرشادية | <p>Indicative content includes the following.</p> <p>Types of Refrigeration Systems [20 hrs]</p> <p>Expansion devices [15 hrs]</p> <p>Steam jet refrigeration [10 hrs]</p> <p>Absorption System Types and Characteristics [15 hrs]</p> <p>Air refrigeration system [10 hrs]</p> |

Learning and Teaching Strategies

استراتيجيات التعلم والتعليم

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|-------------------|---|
| Strategies | Type something like: The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials, and by considering types of simple experiments involving some sampling activities that are interesting to the students. |
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Student Workload (SWL)

الحمل الدراسي للطلاب محسوب لـ ١٥ اسبوعا

| | | | |
|--|------------|---|---|
| Structured SWL (h/sem) الحمل الدراسي المنتظم للطلاب خلال الفصل | 93 | Structured SWL (h/w) الحمل الدراسي المنتظم للطلاب أسبوعيا | 6 |
| Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطلاب خلال الفصل | 82 | Unstructured SWL (h/w) الحمل الدراسي غير المنتظم للطلاب أسبوعيا | 5 |
| Total SWL (h/sem) الحمل الدراسي الكلي للطلاب خلال الفصل | 175 | | |

Module Evaluation

تقييم المادة الدراسية

| | | Time/Number | Weight (Marks) | Week Due | Relevant Learning Outcome |
|-----------------------------|------------------------|-------------|------------------|------------|---------------------------|
| Formative assessment | Quizzes | 3 | 10% (10) | 3,8 and 12 | LO #1, #2,#3,#4,and #6,#7 |
| | Assignments | 3 | 10% (10) | 6,9 and 14 | LO #6,#7and #8 |
| | Projects / Lab. | 15 | 20% (20) | Continuous | All |
| | Report | 0 | 0% (0) | 0 | 0 |
| Summative assessment | Midterm Exam | 2hr | 10% (10) | 7 | LO #1 - #4 |
| | Final Exam | 3hr | 50% (50) | 16 | All |
| Total assessment | | | 100% (100 Marks) | | |



| Delivery Plan (Weekly Syllabus) | |
|---------------------------------|---|
| المنهاج الاسبوعي النظري | |
| | Material Covered |
| Week 1 | Condensers and evaporator types as heat exchangers. |
| Week 2 | Determine the condenser capacity, heat transfer rate, condensing coefficient, and fouling factor. |
| Week 3 | Evaporators, Boiling in the shell, boiling inside the tube, and frosting. |
| Week 4 | Expansion devices: Purpose and types of expansion devices, capillary tube, selection of capillary tube. |
| Week 5 | Absorption refrigeration system: relation between vapor compression and absorption refrigeration units, the absorption refrigeration system, temperature, and concentration properties of LiBr-water solution, calculations of mass flow rates in the absorption cycle, enthalpy of LiBr-water solutions, thermal analysis of simple cycle, |
| Week 6 | Absorption cycle with heat exchanger, crystallization, capacity control, aqua-ammonia system. |
| Week 7-8 | Steam jet refrigeration: system components, working, and analysis of steam jet refrigeration system and determine the coefficient of performance of the system. |
| Week 9 | Cryogenic and liquefaction of gasses: Cryogenic, Joule-Thomson effect, air liquefaction by Hopson system (Joule-Thomson expansion) and Claude system. |
| Week 10 | Compound Vapour Compression System and cascade system. |
| Week 11 | Vortex tube: Types and working principle. |
| Week 12 | Heat Pipe: Types and working principle. |
| Week 13 | Air refrigeration system: the working principle of the cycle |
| Week 14 | Air refrigeration system calculation. |
| Week 15 | The preparatory week before the final Exam. |

| Delivery Plan (Weekly Lab. Syllabus) | |
|--------------------------------------|---|
| المنهاج الاسبوعي للمختبر | |
| | Material Covered |
| Week 1 | Types of condensers and evaporators that are used in the lab. and how to calculate the area of the condenser |
| Week 2 | Find the Log Mean Temperature Difference (LMTD) through the condenser unit. |
| Week 3 | Calculate the overall heat transfer coefficient of the condenser (U). |
| Week 4 | know the difference between the kinds of expansion devices that are used in the lab and study the effect of capillary tubes diameter on refrigerator performance by using refrigerant R134a |
| Week 5 | Test the thermoelectric refrigerator under different power inputs. |



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| Week 6 | Measure theoretically and experimentally the amount of make-up water and the performance of the cooling tower |
| Week 7 | know how the absorption Refrigerator system works and calculate the maximum coefficient of performance of the system. |
| Week 8 | Understand the ESS program and how to use it in different refrigeration systems calculations. |
| Week 9 | Use the ESS program to calculate the performance of compound compression with a water intercooler |
| Week 10 | Use the ESS program to calculate the performance of compound compression with Liquid Refrigerant Intercooler |
| Week 11 | Use the ESS program to calculate the performance of compound compression with Flash Gas Intercooler |
| Week 12 | Use the ESS program to calculate the performance of compound compression with multi evaporator Systems that operate at the same temperature |
| Week 13 | Use the ESS program to calculate the performance of compound compression with multi evaporator Systems using multiple expansion valves and back pressure valves system |
| Week 14 | Use the ESS program to calculate the performance of compound compression with multi-evaporator systems using Individual expansion valve and back pressure valves system |
| Week 15 | Preparatory week before the final Exam |

Learning and Teaching Resources

مصادر التعلم والتدريس

| | Text | Available in the Library? |
|--------------------------|--|---------------------------|
| Required Texts | 1- Refrigeration and Air Conditioning by W. F. Stoecker and J. W. Jones 2- A textbook of Refrigeration and Air Conditioning by R. S. Khurmi and J. K. Gupta | Yes |
| Recommended Texts | ASHRAE Handbook -- Fundamentals SI Edition by ASHRAE | Yes |
| Websites | http://www.learnhvac.org/ | |

Grading Scheme

مخطط الدرجات

| Group | Grade | التقدير | Marks % | Definition |
|-------------------------------------|-------------------------|---------------------|----------|---------------------------------------|
| Success Group (50 - 100) | A - Excellent | امتياز | 90 - 100 | Outstanding Performance |
| | B - Very Good | جيد جدا | 80 - 89 | Above average with some errors |
| | C - Good | جيد | 70 - 79 | Sound work with notable errors |
| | D - Satisfactory | متوسط | 60 - 69 | Fair but with major shortcomings |
| | E - Sufficient | مقبول | 50 - 59 | Work meets minimum criteria |
| Fail Group (0 - 49) | FX – Fail | راسب (قيد المعالجة) | (45-49) | More work required but credit awarded |
| | F – Fail | راسب | (0-44) | Considerable amount of work required |
| | | | | |

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.

| Code | Course/Module Title | ECTS | Semester |
|---|-----------------------|---------------|---------------|
| RAC 401 | Refrigeration Systems | 7 | 7 |
| Class (hr/w) | Lect/Lab./Prac./Tutor | SSWL (hr/sem) | USWL (hr/sem) |
| 3 | 3 | 93 | 82 |
| Description | | | |
| <p>This model aims to enhance the student's knowledge of the principles of vapor compression refrigeration systems and their analysis, also studying types of refrigeration units and cryogenic refrigeration. As well as the refrigeration system is a group of components used for cooling and sometimes heating. In most cases, it involves the use of a thermodynamic cycle in which there is a flow of heat from one place to another. In simpler terms, it's a system that can cool and maintain temperatures within a given range. It's usually mechanical but can also be achieved by using simple means such as using water or any other liquid to lower the temperature. In this course, we will learn about different types of refrigeration systems and their functions. This will teach us how refrigerators work.</p> | | | |