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|  <div> TEACHING PLAN UNIVERSITI TEKNIKAL MALAYSIA MELAKA FAKULTI KEJURUTERAAN MEKANIKAL </div> | | |
| MECHANICAL ENGINEERING LABORATORY III | | |
| BMCG3011 | SEMESTER 2 | SESI 2021/2022 |

1.0 OBJECTIVE

The objective of this course is to introduce students to engineering practice in the field of Thermodynamics, Fluid Mechanics and Solid Mechanics.

2.0 LEARNING OUTCOMES

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

- LO1** Observe discipline in attending laboratory sessions, applied safety precautions before, during and after conducting experiments in terms of experimental procedures and aware of the general experimental ethics. **(PO10, CS3)**
- LO2** Plan, design and conduct experiments to prove a proposed hypothesis out of a given real and practical engineering problem. **(PO2, C3)**
- LO3** Write a well organised, sensible and readable technical reports. **(PO9, C6)**

3.0 SYNOPSIS

Introduction to safety procedures in a laboratory. Hypothesis formulation. Design of experiments. Data analysis. Use of graphical presentation techniques for experimental data. Error and uncertainty. Measurement accuracy and precision. Statistical analysis. Good laboratory report writing.

The experiments will be conducted in mechanical engineering laboratories that study fundamental engineering concepts in:-

A) SOLID MECHANICS

i) Stress-strain Analysis of a Simple Beam

Synopsis

For a simple supported beam, it can be proved that the nominal or bending stress along the beam may be determined from the general formula of bending theory.

Objective

- to analyze the strain-stress behaviour of a simply supported beam through stress-strain measurement method by using strain gauges.

ii) **Thin & Thick Cylinder Analysis**

Synopsis

Stresses systems or distributions between thin and thick cylinders.

Objective

- to analyze, determine and compare the stresses systems for the thin and thick walled pressure vessels or cylinders.

iii) **Curve & Davit Test**

Synopsis

The load systems to the four test structures; quarter circle, semicircle, curved davit and angled davit structures.

Objective

- To apply strain energy concept to define the deformation of a structure in terms of its horizontal and vertical deflections for the four test structures; quarter circle, semicircle, curved davit and angled davit structures.

iv) **Strut Buckling**

Synopsis

Compressive loads always lead to exhibit elastic instabilities. One type of elastic instabilities is known as buckling. Buckling is a failure of structural abilities due to over maximum compressive load.

Objective

- To observe and determine the buckling behaviour and critical load for a pinned and a fixed end strut.

B) FLUID MECHANICS

i) **Boundary Layers**

Synopsis

Boundary layer, in fluid mechanics, thin layer of a flowing gas or liquid in contact with a surface such as that of an airplane wing or of the inside of a pipe. The fluid in the boundary layer is subjected to shearing forces. A range of velocities exists across the boundary layer from maximum to zero, provided the fluid is in contact with the surface. Boundary layers are thinner at the leading edge of an aircraft wing and thicker toward the trailing edge. The flow in such boundary layers is generally laminar at the leading or upstream portion and turbulent in the trailing or downstream portion.

Objective

- To investigate the characteristics of the velocity distribution in a boundary layer on smooth and rough surfaces of plates.

ii) **Drag Measurement**

Synopsis

As an object moves through a fluid it experiences forces from the interaction with the fluid. Forces in the direction of the object's motion are referred to as drag. Drag forces act against the object motion, and are in general dependent on the velocity. Depending on the flows conditions different phenomena could be responsible for drag creation.

Objective

- To determine the drag coefficient of a circular cylinder using direct weighing and pressure distribution methods.

iii) **Laminar Flow Visualisation**

Synopsis

The concept of a boundary layer and dealt with the effects viscosity has on a fluid adjacent to solid surface and with the calculation of forces acting on the surface due to fluid friction. The knowledge of potential flow and of boundary layer theory makes it possible to treat an external flow problem as consisting broadly of two distinct regimes that immediately adjacent to the body's surface, where viscosity is predominant and where frictional force is generated, and that outside the boundary layer, where viscosity is neglected but velocities and pressure are affected by the physical presence of the body together with its associated boundary layer.

Objective

- To investigate and analyse the flow pattern of different geometry body submerged in a fluid.

iv) **System and Pump Characteristics**

Synopsis

The most common machine for causing liquids to flow through piping systems is the centrifugal pump. The centrifugal pump is well suited to situations requiring moderate to high flowrates and modest increases in head (or pressure). Typical applications include municipal water supply systems, and circulating water heating and cooling system for buildings. For very high pressure, low flow applications, positive displacement pumps are more suitable. Positive displacement pumps move fluids with pistons, gears or vanes and flowrate is a function of rotational speed and has little if any dependence on the pressure rise. A common application of a positive displacement pump is that used to supply high pressure oil for hydraulic actuators such as those on a large earth moving machines.

Objective

- To determine the system and pump characteristic curves for a pump by establishing the operating point of the pump.

C) **THERMODYNAMICS**

i) **Cooling and Dehumidification Process**

Synopsis

Air Conditioning system is used as the control of the atmosphere so that a desired temperature, humidity, distribution and movement are achieved. Usually, cooling and dehumidification process is used in air conditioning system. Cooling is a heat removable process from close space to others in order to reduce and maintain the space temperature while dehumidification is a moisture removable process from the air without change in its dry bulb temperature.

Objective

- To illustrate the cooling and dehumidification process on Psychometric Chart.
- To learn about the planning of a measurement series, the reading of measurement results and the conversion of measurements into a statement of theoretical principle.

ii) **Water Cooling Tower System**

Synopsis

The evaporation process use by the cooling tower to lowering the temperature of the water that's being circulated throughout the system. The purpose of a cooling tower is to cool down water that gets heated up by industrial equipment and processes. Water comes in the cooling tower hot (from industrial process) and goes out of the cooling tower cold (back into the industrial process).

Objective

- To investigate the relationship between cooling load and cooling range.

iii) **Linear Heat Conduction**

Synopsis

Thermal conduction is the transfer of heat energy in a material due to the temperature gradient within it. It always takes place from a region of higher temperature to a region of lower temperature. A solid is chosen for the experiment of pure conduction because both liquids and gasses exhibit excessive convective heat transfer. For practical situation, heat conduction occurs in three dimensions, a complexity which often requires extensive computation to analyse. For experiment, a single dimensional approach is required to demonstrate the basic law that relates rate of heat flow to temperature gradient and area.

Objective

- To determine the thermal conductivity (k) of a metal specimen by using linear heat conduction.

iv) **Radial Heat Conduction**

Synopsis

Thermal conduction is the transfer of heat energy in a material due to the temperature gradient within it. It always takes place from a region of higher temperature to a region of lower temperature. A solid is chosen for the experiment of pure conduction because both liquids and gasses exhibit excessive convective heat transfer. For practical situation, heat conduction occurs in three dimensions, a complexity which often requires extensive computation to analyse. For experiment, a single dimensional approach is required to demonstrate the basic law that relates rate of heat flow to temperature gradient and area.

Objective

- To determine the thermal conductivity (k) of a brass specimen by using radial heat conduction.

4.0 REFERENCES

- a. Wheeler, A.J. and Ganji, A.R., 2010. *Introduction to Engineering Experimentation*, 3rd Ed., International Edition Pearson.
- b. Cengel, Y. A. and Boles, M. A., 2007. *Thermodynamics: An Engineering Approach*, 6th Ed., McGraw Hill. Singapore
- c. Yuan, C.S., 2006, *Fluid Mechanics II*, Pearson Prentice Hall, Malaysia.
- d. Hibbeler, R. C., 2007, *Solid Mechanics*, 7th Ed., Prentice Hall.
- e. Varinder Taprial, Priya Kanwar. 2018, *Heating, Ventilation & Air-Conditioning*, 1st Edition, bookboon.com Ltd.

6.0 COURSE INSTRUCTIONS

Attendance is compulsory for all laboratory sessions including briefing and discussion sessions and should be more than 80% of the total contact hours.

7.0 SUBJECT ASSESSMENTS

| No | Learning Outcome | Program Outcome | Assessment Method | Mark Code Knowledge Profile (WK) | Complex Problem Solving (WP) | Complex Engineering (EA) | Mark Code | Percentage (%) |
|----------------------------|------------------|-----------------|---|----------------------------------|------------------------------|--------------------------|-----------|----------------|
| 1 | 1 | 10 | Direct Observation <ul style="list-style-type: none"> • Attendance (x 5%) • Team work (x 5%) • Communication & Interactions (x 5%) | | | 1, 2, 3 | LA-1 | 15 |
| 2 | 2 | 2 | Experiment Proposal Report <ul style="list-style-type: none"> • 1 report x 15 % | 3 | 1, 3, 5 | | LA-2 | 15 |
| 3 | 3 | 9 | Final Report <ul style="list-style-type: none"> • 1 report x 70 % | | | | LR-1 | 70 |
| Total | | | | | | | | 100 |
| 4 experiments x 100 | | | | | | | | 400 |

Any report found to be of plagiarism in nature will be given minimum mark of 0%.

8.0 EXPERIMENT ACTIVITIES SCHEDULES

LAB SCHEDULE

| | | | LAB1 | LAB2 | LAB3 | LAB4 | | | | | | | | | | |
|-----|---------------------|-----------|-----------|----------|---------------------------|-----------|---|-----------|---------------------------|---------------------------|-------------------------|----------------|---|-------------------------|-------------------------|--|
| EXP | W1 | W2 | W3 | W4 | W5 | W6 | W7 | W8 | W9 | W10 | W11 | W12 | W13 | W14 | W15 | |
| | 7.3-11.3 | 14.3-18.3 | 21.3-25.3 | 28.3-1.4 | 4.4-8.4 | 11.4-15.4 | 18.4-22.4 | 25.4-29.4 | 2.5-6.5 | 9.5-13.5 | 16.5-20.5 | 23.5-27.5 | 30.5-3.6 | 6.6-10.6 | 13.6-17.6 | |
| S1 | ONLINE LAB BRIEFING | | A | C | LAB 1 PROPOSAL SUBMISSION | E | LAB 2 PROPOSAL SUBMISSION (INDIVIDUAL) | D | LAB 3 PROPOSAL SUBMISSION | LAB 4 PROPOSAL SUBMISSION | LAB 1 REPORT SUBMISSION | MID-TERM BREAK | LAB 2 REPORT SUBMISSION (INDIVIDUAL) | LAB 3 REPORT SUBMISSION | LAB 4 REPORT SUBMISSION | |
| S2 | | | I | K | | G | | L | | | | | | | | |
| S3 | | | B | D | | F | | E | | | | | | | | |
| S4 | | | J | L | | H | | G | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| F1 | | | C | E | | A | | F | | | | | | | | |
| F2 | | | K | G | | I | | H | | | | | | | | |
| F3 | | | D | F | | B | | C | | | | | | | | |
| F4 | | | L | H | | J | | K | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| T1 | | | E | A | | C | | B | | | | | | | | |
| T2 | | | G | I | | K | | J | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| H1 | | | F | B | | D | | A | | | | | | | | |
| H2 | | | H | J | | L | | I | | | | | | | | |

*A, B, C, D, E, F, G, H, I, J, K, L - students' lab group

Air conditioning Lab

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|------------------|----|
| Air conditioning | T1 |
| Cooling Tower | T2 |

Heat Transfer Lab

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|------------------------|----|
| Linear Heat Conduction | H1 |
| Radial Heat Conduction | H2 |

Dynamic Lab

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|------------------------|----|
| Stress Strain Analysis | S1 |
|------------------------|----|

Structure Mechanics Lab

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|------------------------------|----|
| Thin-Thick Cylinder Analysis | S2 |
| Curved Bar Davits Test | S3 |
| Strut-Buckling | S4 |

Fluid Mechanics Lab

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|---------------------------------|----|
| Boundary Layers | F1 |
| Drag Measurement | F2 |
| Laminar Flow Visualization | F3 |
| System and Pump Characteristics | F4 |

9.0 STAFF

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TEACHING PLAN APPROVAL

Prepared by;

Approved by;

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Position: Lecturer

Stamp :

Stamp :

Date : _____

Date : _____

TEACHING PLAN IMPLEMENTATION (MID SEMESTER BREAK)

Comment:

Checked by;

.....
Dean/Deputy Dean (Academic)/Head of Department
Stamp :

Date : _____

TEACHING PLAN IMPLEMENTATION (WEEK 16 OF THE SEMESTER)

Comment:

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