

ROY G. PERRY COLLEGE OF ENGINEERING
CHEMICAL ENGINEERING DEPARTMENT
PRAIRIE VIEW A&M UNIVERSITY

ASSESSMENT REPORT COVER PAGE

CHEG 3023 UNIT OPERATIONS

FALL 2020 SEMESTER

NAME OF INSTRUCTOR: Dr. Keisha Antoine

Revised: 12/20/2020

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Detailed Course Syllabus
(Distributed to Students at the beginning of the Semester)
ABET Outcomes measured using course should be
explicitly listed in the syllabus

ABET Format Course Syllabus

CHEG 3023 UNIT OPERATIONS

1.	Course number and name:	CHEG 3023 UNIT OPERATIONS
2.	Credits and contact hours:	3 credit hours; 5 contact hours
3.	Instructor's or course coordinator's name:	Dr. Keisha Antoine
4.	Textbook: Title:	UNIT OPERATIONS OF CHEMICAL ENGINEERS
	Author:	McCabe Smith
	Publisher, Year & Edition:	McGraw-Hill Book Company, New York, 2005, 7 th Edition
	a. Other Supplemental material	N. de Nevers, Fluid Mechanics for Chemical Engineers. 3rd edition, McGraw-Hill, 2005, ISBN: 978-0-07-256608-6
5.	Specific course information	
	a. Brief description of the content of the course (catalog description)	CHEG 3023 Unit Operations. (3-0) Credit 3 semester hours. The fundamental conservation laws in fluid statics and dynamics are derived and solved analytically and numerically. Analysis of incompressible flow; laminar and turbulent flows in pipes; hydraulic machinery; and introduction to compressible flow. Direct applications to problems encountered in practice will be emphasized.
	b. Prerequisites or Co-requisites	CHEG 2053 Material and Energy Balance
	c. *Indicate whether a required, elective, or selected elective (as per definition provided) course in the program	Required
6.	a. Specific goals for the course specific outcomes of instruction (e.g., The student will be able to explain the significance of current research about a particular topic.) <i>Students will be able to:</i>	b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course. <i>The specific goals for the course specific outcomes listed on the left column will address the following student learning outcomes:</i>
	1. Ability to Define/Understand the Problem and then Plan the Project.	Outcome 2.1 Students will perform a group laboratory experiment to

	2. Ability to Conduct a Review of the Literature and perform preliminary design by generation of ideas and applying creativity. 3. Ability to perform detailed engineering design. 4. Acquire new knowledge using the appropriate learning strategies. 5. Apply new knowledge to solve problems.	understand the concept of hydrostatic pressure. Students will perform a data analysis exercise using EXCEL to develop the performance characteristics of a centrifugal pump (Edibon PBCC). Students will perform a group laboratory experiment to understand the concept of mechanical energy conservation, i.e., the application of the Bernoulli equation. Students will be evaluated on the concepts of momentum balance, viscosity, Bernoulli equation in the final exam. Outcome 7 See items listed for Outcome 2.1
7	Brief list of topics to be covered	Introduction, Fluid Properties (5 hours) Fluid Statics and its applications (10 hours) Fluid Flow Phenomena (10 hours) Basic Equations of Fluid Flow (6 hours) Dimensional Analysis (4 hours) Incompressible flow in pipes and channels (6 hours) Transportation and Metering of Fluids (3 hours) Pumps (9 Hours) Turbomachinery (4 hours) Laboratory Experiments (5 hours)

***Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group

General Course Information

Information Item	Information
Instructor:	Dr. Keisha Antoine
Section # and CRN:	Y02; CRN 16916
Office Location:	C.L. WILSON 201E and Virtual
Office Phone:	936-261-9407
Email Address:	keantoine@pvamu.edu
Office Hours:	MWF 10-11AM; 3-5PM
Mode of Instruction:	Hybrid
Course Location:	Gilchrist 104
Class Days & Times:	MWF 2:15-3:05PM
Catalog Description:	CHEG 3023 Unit Operations: 3 semester hours. Application of transport theory to the design of equipment for the pumping and transfer of fluids through pipes, heat exchange, interphase transfer of heat and mass for the separation and purification of process streams.
Prerequisites:	CHEG 2053 .
Co-requisites:	NA
Required Text(s):	Unit Operations of Chemical Engineers, 7th Edition, McCabe, Smith and Harriott, McGraw-Hill, 2005, ISBN: 0-07-284823-5
Recommended Text(s):	Fluid Mechanics for Chemical Engineers, 3 rd edition, N. de Nevers, McGraw-Hill, 2005, ISBN: 978-0-07-256608-6

General Course Information Table

Student Learning Outcomes:

Upon successful completion of this course, students will be able to:	Program Learning Outcome Alignment	Core Curriculum Outcome Alignment
1. Chapter 1 Understand unit systems, dimensional analysis and equations of state of gases, the meaning of unit operations	PEO 1, 3	2, 7
2. Chapter 2 - Understand hydrostatic equilibrium, the concept of pressure - Understand the different relationship between different units of pressure.	PEO 1, 3	2, 7
3. Chapter 3 - Understand fluid flow phenomena: laminar flow, shear rate and shear stress, rheological properties of fluids, turbulence, boundary layers - Understand the concept of viscosity. - Recognize a Newtonian fluid - Calculate viscosities using different empirical formulas or with data available in the Appendix - Be able to calculate Reynolds number and understand the relationship of this dimensionless number to laminar and turbulent flow regimes.	PEO 1, 3	2, 7
4. Chapter 4 - Understand the concept of head and how it relates to pressure. - Understand equations of fluid flow: mass balance in a flowing fluid; continuity and how to apply these concepts - Understand the applications of momentum balance; equations of motion and how to apply them	PEO 1, 3	2, 7

- Understand how the Bernoulli equation relates to the mechanical energy equation. - Understand mechanical energy equation and its application - Know how to use the appendices to find OD, ID, wall thickness, etc. of standard steel pipe; to find properties of liquid water; to find viscosities of liquids and gases		
5. Chapter 5 - Understand incompressible flow in pipes and channels - Calculate friction factor for laminar and turbulent regimes of flow. Name and describe the two atomic mechanisms of diffusion. - Recognize the Moody diagram and know how to use it to calculate pipe roughness, friction factor or Reynolds	PEO 1, 3	2, 7
6. Chapter 8 - Learn about transport and metering of fluids through pipe, fittings, valves and pumps - Apply continuity, momentum balance and mechanical energy balance equations in fluid flow through pipes, fittings, valves and pumps - Learn about Affinity laws	PEO 1, 3	2, 7

Student Learning Outcomes Table

ABET OUTCOMES:

Course Outcome 1: This outcome is the same as program outcome 2.

An ability to (1) apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factor

1. Ability to Define/Understand the Problem and then Plan the Project

1. Ability to identify the specific needs to be met by defining/understanding the Problem and developing plans for the project to satisfy the need.

Students are able to:

- (i) Identify the customer and the specific needs to be met by the design,
- (ii) Identify and list the design objectives,
- (iii) Identify the design constraints,
- (iv) Define the design requirements, strategy and methodology,
- (v) Identify and break down work into tasks and subtasks and identify the personnel and deliverables for each,
- (vi) Develop a project management plan using, Gantt charts and critical path analysis,
- (vii) Establish major milestones for tracking progress and define performance metrics to measure success

2. Ability to Conduct a Review of the Literature and perform preliminary design by generation of ideas and applying creativity

The students is able to:

- (i) Identify the types of information needed for a complete understanding of all aspects of the project (Based on task described in the project planning),
- (ii) Gather information on relevant fundamentals, theory / concept (demonstrate technical competence) and relate them to the design,
- (iii) Provide the sources in a list of references properly cited in the literature review section and relevant sections of the report,
- (iv) Define functional requirements for design (Specific required actions needed to be performed for the design to be achieved),
- (v) Transform functional requirements into candidate solutions / mathematical modeling, and (vi) evaluate candidate solutions to arrive at feasible designs.

Course Outcome 2: This outcome is the same as program outcome 7.

Students will have an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The two performance criteria used to measure this outcome are:

1. Ability to provide clear and concise information regarding a chemical engineering unit operations project.

Given a problem, the student is able to:

- (i) Prepare a written report of based on experimental analysis and literature review.
- (ii) Design a system to meet a desired need.
- (iii) Present results from experiments in a PowerPoint or similar method of presentation.
- (iv) Depict preliminary results in the form of abstracts, memos, and project summaries.
- (v) Understand the basic operation of equipment.
- (vi) Describe the parts to pumps, valves, flanges, etc.
- (vii) Discuss the operation of units in a PowerPoint presentation.

2. Ability to acquire critical information necessary for a chemical engineering unit operations project using appropriate tools and strategies.

Given a problem, the student is able to:

- (i) Perform a literature review through search engine, databases, and library resources.
- (ii) Read table and graphs to determine properties such as friction factor, drag, or Reynold's number and use information in calculations and design.
- (iii) Use journal articles and book to gather information.
- (iv) Conduct interviews from vendors or experts to gain an understanding of a process or cost of equipment.

Major Course Requirements

Method of Determining Final Course Grade

Course Grade Requirement	Value	Total
1. Homework	10	10
2. Quizzes	20	20
3. Participation-Discussion Posts, In-session chats	5	5
4. Exams	40	40
5. Final Exam	25	25
Total:		100

Course Grade Requirement Table

Grading Criteria and Conversion:

A = 90-100 points

B = 80-89 points

C = 70-79 points

D = 60-69 points

F = 59 points and below

A signifies that the student has mastered the subject matter and understands all concepts covered.

B signifies that the student has a good understanding of the subject matter with few exceptions.

C signifies that the student has an adequate understanding of the material and can follow most concepts.

D signifies that the student does not understand important class concepts needed to be successful in future courses.

F signifies that the student has missed significant assignments or does not understand several concepts.

Detailed Description of Major Assignments:

Assignment Title or Grade Requirement	Description
1.Homework	The homework assignments will allow students to gain understanding of the aforementioned learning outcomes.
2.Quizzes	The quizzes will be administered online and will test student knowledge of the learning outcomes
3.Exams	Exams will be administered online and will test student knowledge of the learning outcomes. One of the exams may be a group project.
4.Final Exam	The Final Exam will be administered online and will be a comprehensive exam to test student knowledge of the learning outcomes.

Detailed Description of Major Assignments Table

Course Procedures or Additional Instructor Policies

Taskstream

Taskstream is a tool that Prairie View A&M University uses for assessment purposes. One of your assignments may be required to be submitted as an "artifact," an item of coursework that serves as evidence that course objectives are met. If applicable, more information will be provided during the semester by your department, but for general information, you can visit Taskstream via the link in eCourses.

Tests & Testing Policy

All tests are open book and open notes. Make-up exams are only available for students with university excused absences. In most cases, the make-up exam is given BEFORE the student misses the exam. No collaboration among students is allowed during the exam. No electronic devices will be allowed including iPads and eReaders.

No graphing or programmable calculators are allowed for any test or quiz. Students must purchase a small scientific calculator to use on exams. A cell phone cannot be used as a replacement for a calculator on an exam. Doing so will result in a zero. No bathroom breaks are allowed during a test. If a student leaves the room during this time, their exam/quiz will be collected and considered finished by the student. Any act of cheating will result in a grade of zero for that student, and the student will be referred to the department head. Such meetings must take place within a week of the violation.

Homework Policy & Guidelines

This course involves the usage of computer software. ***Students must submit these assignments BEFORE the beginning of class.*** If a student chooses to disobey the university's honor code and copy the solution manual instead of submitting the student's own independent work, the student will receive a grade of zero on the assignment and will be referred to the department head. Such meetings must take place within a week of the infraction. Staple assignment if it is more than one page. Write your name, date, and assignment number on the front page. Homework is due at the beginning of the class period. ***Late homework assignments will NOT be accepted.***

Class Activities And Participation

Classes are hybrid and as such will be administered in face-to-face format and internet-synchronous online sessions over ZOOM. Given the pandemic, additional flexibility is permitted to allow for a HyFlex approach to Hybrid courses as well, e.g., the 15% minimum Face-to-Face component may be satisfied using synchronous Zoom-based meetings. Thus, ALL classes will be delivered in internet-synchronous online sessions over ZOOM, and these sessions will count towards the face-to-face requirement. Additionally, all sessions will be recorded and posted to Canvas. Students are expected to attend class sessions on a regular basis and are expected to participate in classroom discussions. Students must submit these assignments during a given time frame.

Semester Calendar

Modules	Topic	Online Assignment/Activity (Due Date)	Assignment/ Activity (Face-to-Face[F2F])
Module 1 ZOOM Meeting August 24, 2020	Course Introduction; Meet & Greet; Review of Syllabus; Introduction to Unit Operations	- Review the syllabus (August 24, 2020) - Chapter 1 (August 28, 2020)	TBD
Module 2 ZOOM Meeting August 31, 2020	Fluid Statics and Its Applications	Chapter 2 (August 31– September 11, 2020)	TBD
Module 3 ZOOM Meeting September 14, 2020	Fluid Flow Phenomena	Chapter 3 (September 14- 23, 2020)	TBD
Module 4 ZOOM Meeting September 28, 2020	Basic Equations of Fluid Flow	Chapter 4 (September 28- October 7)	TBD
Module 5 ZOOM Meeting October 9, 2020	Incompressible Flow in Pipes and Channels	Chapter 5 (October 9-16, 2020)	TBD
Module 6 ZOOM Meeting October 21, 2020	Transportation and Metering of Fluids	Chapter 8 (October 21- November 20, 2020)	TBD
	Final Exam Review	(November 23, 2020)	
Final Exam			

Student Support and Success

John B. Coleman Library

The library and its partners have as their mission to provide resources and instructional material in support of the evolving curriculum, as a partner in Prairie View A&M University's mission of teaching, research, and service and to support the University's core values of access and quality, diversity, leadership, relevance, and social responsibility through emphasis on ten key areas of service. It maintains library collections and access both on campus, online, and through local agreements to further the educational goals of students and faculty. Phone: 936-261-1500; Website: [J. B. Coleman Library](#).

Academic Advising Services

Academic Advising Services offers students a variety of services that contributes to student success and leads towards graduation. We assist students with understanding university policies and procedures that affect academic progress. We support the early alert program to help students get connected to success early in the semester. We help refer students to the appropriate academic support services when the student is unsure of the best resource for their needs. Some students are supported by faculty advisors in their respective colleges. Your faculty advisor can be identified in PantherTracks. Advisors with Academic Advising Services are available to all students. We are located across campus. You can find your advisor's location by academic major at the [Academic Advising Website](#), Phone: 936-261-5911.

The University Tutoring Center

The University Tutoring Center (UTC) offers free tutoring and academic support to all registered PVAMU students. The mission of the UTC is to help provide a solid academic foundation that enables students to become confident, capable, independent learners. Competent and caring staff and peer tutors guide students in identifying, acquiring, and enhancing the knowledge, skills, and attitudes needed to reach their desired goals. Tutoring and academic support is offered face-to-face in the [UTC, in virtual face-to-face sessions](#), and through [online sessions at PVPlace](#). Other support services available for students include Supplemental Instruction, Study Break, Academic Success Workshops, and Algebra Study Jam. Location: J. B. Coleman Library, Rm. 307; Phone: 936-261-1561; Email: pvtutoring@pvamu.edu; Website: [University Tutoring Center](#).

The Writing Center

The Writing Center provides well-trained peer tutors that assist students with writing assignments at any stage of the writing process. Tutors help students with various writing tasks from understanding assignments, brainstorming, drafting, revising, editing, researching, and integrating sources. Students have free access to Grammarly online writing assistance. Grammarly is an automated proofreading and plagiarism detection tool. Student must register for Grammarly by using their student email address. In addition, students have access to face-to-face as well as virtual tutoring services either asynchronously via email or synchronously via Zoom. Location: J. B. Coleman Library, Rm. 209; Phone: 936-261-3724; Website: [The Writing Center](#); [Grammarly Registration](#).

Academic Early Alert

Academic Early Alert is a proactive system of communication and collaboration between faculty, academic advisors, and PVAMU students that is designed to support student success by promptly identifying issues and allowing for intervention. Academic Early Alert helps students by providing a central location to schedule advising appointments, view advisor contact information, and request assistance. Students who recognize that they have a problem that is negatively affecting their academic performance or ability to continue school may self-refer an Academic Early Alert. To do so, students will log in to PVPlace and click on Academic Early Alert on the left sidebar. Phone: 936-261-5902; Website: [Academic Early Alert](#).

Student Counseling Services

The Student Counseling Services unit offers a range of services and programs to assist students in maximizing their potential for success: short-term individual, couples, and group counseling, as well as crisis intervention, outreach, consultation, and referral services. The staff is licensed by the State of Texas and provides assistance to students who are dealing with academic skills concerns, situational crises, adjustment problems, and emotional difficulties. Information shared with the staff is treated confidentially and in accordance with Texas State Law. Location: Hobart Taylor, 2nd floor; Phone: 936-261-3564; Website: [Student Counseling Services](#).

Office of Testing Services

Testing Services serves to create opportunities by offering suite of exams that aid in the students' academic and professional success. Currently we administer entrance (HESI A2), college readiness (TSI assessment), Prior Learning (CLEP, DSST), and proctored exams. Location: Wilhelmina Delco, 3rd Floor, Rm. 305; Phone: 936-261-3627; Email: aetesting@pvamu.edu; Website: [Testing Services](#).

Office of Diagnostic Testing and Disability Services

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, contact the Office of Disability Services. As a federally-mandated educational support unit, the Office of Disability Services serves as the repository for confidential disability files for faculty, staff, and students. For persons with a disability, the Office develops individualized ADA letters of request for accommodations. Other services include: learning style inventories, awareness workshops, accessibility pathways, webinars, computer laboratory with adapted hardware and software, adapted furniture, proctoring of non-standardized test administrations, ASL interpreters, ALDs, digital recorders, livescribe, and a comprehensive referral network across campus and the broader community. Location: Hobart Taylor, Rm. 1D128; Phone: 936-261-3583; Website: [Disability Services](#).

Center for Instructional Innovation and Technology Services (CIITS)

Distance Learning, also referred to as Distance Education, is the employment of alternative instructional delivery methods to extend programs and services to persons unable to attend college in the traditional manner. The Center for Instructional Innovation and Technology Services (CIITS) supports student learning through online, hybrid, web-assisted and 2-way video course delivery. For more details and contact information, visit: [CIITS Student Webpage](#); Phone: 936-261-3283.

Veteran Affairs

Veteran Services works with student veterans, current military and military dependents to support their transition to the college environment and continued persistence to graduation. The Office coordinates and certifies benefits for both the G.I. Bill and the Texas Hazlewood Act. Location: Evans Hall, Rm. 102; Phone: 936-261-3563; Website: [Veteran Affairs](#).

Office for Student Engagement

The Office for Student Engagement delivers comprehensive programs and services designed to meet the co-curricular needs of students. The Office implements inclusive and accessible programs and services that enhance student development through exposure to and participation in diverse and relevant social, cultural, intellectual, recreational, community service, leadership development and campus governance. Location: Memorial Student Center, Rm. 221; Phone: 936-261-1340; Website: [Office for Student Engagement](#).

Career Services

Career Services supports students through professional development, career readiness, and placement and employment assistance. The Office provides one-on-one career coaching, interview preparation, resume and letter writing, and career exploration workshops and seminars. Services are provided for students at the Northwest Houston Center and College of Nursing in the Medical Center twice a month or on a requested basis. Distance Learning students are encouraged to visit the Career Services website for information regarding services provided. Location: Anderson Hall, 2nd floor; Phone: 936-261-3570; Website: [Career Services](#).

University Rules and Procedures

Academic Misconduct (See Student Planner)

You are expected to practice academic honesty in every aspect of this course and all other courses. Make sure you are familiar with your Student Planner, especially the section on academic misconduct (see *University Administrative Guidelines on Academic Integrity*). Students who engage in academic

misconduct are subject to university disciplinary procedures. As listed in the PVAMU Undergraduate Catalog, Graduate Catalog, and the Student Planner, the following are examples of prohibited conduct. This list is not designed to be all-inclusive or exhaustive. In addition to academic sanctions, any student found to have committed or to have attempted to commit the following academic misconduct may also be subject to disciplinary review and action as outlined in the PVAMU Student Planner.

Forms of Academic Dishonesty:

1. Cheating: Deception in which a student misrepresents that he/she has mastered information on an academic exercise that he/she has not learned, giving or receiving aid unauthorized by the instructor on assignments or examinations. Examples: unauthorized use of notes for a test; using a "cheat sheet" on a quiz or exam; any alteration made on a graded test or exam which is then resubmitted to the teacher.
2. Plagiarism: Careless or deliberate use of the work or the ideas of another; representation of another's work, words, ideas, or data as your own without permission or appropriate acknowledgment. Examples: copying another's paper or answers, failure to identify information or essays from the Internet and submitting or representing it as your own; submitting an assignment which has been partially or wholly done by another and claiming it as yours; not properly acknowledging a source which has been summarized or paraphrased in your work; failure to acknowledge the use of another's words with quotation marks.
3. Multiple Submission: Submission of work from one course to satisfy a requirement in another course without explicit permission. Example: using a paper prepared and graded for credit in one course to fulfill a requirement and receive credit in a different course.
4. Conspiracy: Agreeing with one or more persons to commit an act of academic/scholastic dishonesty.
5. Fabrication of Information/Forgery: Use or submission of contrived, invented, forged, or altered information in any assignment, laboratory exercise, or test; tampering with or production of a counterfeit document, particularly documents which make up the student's academic record. Examples: making up a source or citing nonexistent publication or article; representing made up data as real for an experiment in a science laboratory class; forging a change of grade or student withdrawal record; falsifying any document related to a student academic exercise.

Nonacademic Misconduct (See Student Planner)

The University respects the rights of instructors to teach and students to learn. Maintenance of these rights requires campus conditions that do not impede their exercise. Campus behavior that interferes with either (1) the instructor's ability to conduct the class, or (2) the ability of students to benefit from the instructional program, or (3) the rights of others will not be tolerated. An individual engaging in such disruptive behavior may be subject to disciplinary action. Such incidents will be adjudicated by the Office for Student Conduct under nonacademic procedures.

Sexual Misconduct

Sexual harassment of students and employees at Prairie View A&M University is unacceptable and will not be tolerated. Any member of the university community violating the university's sexual harassment policy will be subject to disciplinary action. In accordance with the Texas A&M University System guidelines, your instructor is obligated to report to the Office of Title IX Compliance (titleixteam@pvamu.edu) any instance of sexual misconduct involving a student, which includes sexual assault, stalking, dating violence, domestic violence, and sexual harassment, about which the instructor becomes aware during this course through writing, discussion, or personal disclosure. The faculty and staff of PVAMU actively strive to provide a learning, working, and living environment that promotes respect that is free from sexual misconduct, discrimination, and all forms of violence. If students, faculty, or staff would like assistance, or have questions, they may contact the Title IX Coordinator at 936-261-2144 or titleixteam@pvamu.edu. More information can be found at the [Title IX Webpage](#) including confidential resources available on campus.

Pregnancy, Pregnancy-related, and Parenting Accommodations

Title IX of the Education Amendments of 1972 prohibits sex discrimination, which includes discrimination based on pregnancy, marital status, or parental status. Students seeking accommodations related to pregnancy, pregnancy-related condition, or parenting (reasonably immediate postpartum period) are

encouraged to contact Student Disability Services or the Dean of Students' Office for additional information and to request accommodations. More information can be found at this [webpage](#).

Non-Discrimination Statement

Prairie View A&M University does not discriminate on the basis of race, color, sex, religion, national origin, age, disability, genetic information, veteran status, sexual orientation or gender identity in its programs and activities. The University is committed to supporting students and complying with the Texas A&M University System non-discrimination policy. It seeks to establish an environment that is free of bias, discrimination, and harassment. If you experience an incident of discrimination or harassment, we encourage you to report it. If you would like to speak with someone who may be able to afford you privacy or confidentiality, there are individuals who can meet with you. The Director of Equal Opportunity & Diversity has been designated to handle inquiries regarding the non-discrimination policies, and can be reached at Harrington Science Building, Suite 109 or by phone 936-261-1744 or 1792.

Class Attendance Policy (See Catalog for Full Attendance Policy)

Prairie View A&M University requires regular class attendance. Attending all classes supports full academic development of each learner whether classes are taught with the instructor physically present or via distance learning technologies such as interactive video and/or internet. Excessive absenteeism, whether excused or unexcused, may result in a student's course grade being reduced or in assignment of a grade of "F". Absences are accumulated beginning with the first day of class during regular semesters and summer terms. Each faculty member will include the University's attendance policy in each course syllabus.

Student Academic Appeals Process

Authority and responsibility for assigning grades to students rests with the faculty. However, in those instances where students believe that miscommunication, errors, or unfairness of any kind may have adversely affected the instructor's assessment of their academic performance, the student has a right to appeal by the procedure listed in the University Catalog and by doing so within thirty days of receiving the grade or experiencing any other problematic academic event that prompted the complaint. Students can file Academic Complaints and/or Grade Appeals at this [webpage](#).

Technical Considerations

Minimum Recommended Hardware and Software:

- Intel PC or Laptop with Windows 10 or later version; Mac with OS High Sierra*
- Smartphone or iPad/Tablet with Wi-Fi*
- High speed Internet access
- 8 GB Memory
- Hard drive with 320 GB storage space
- 15" monitor, 800x600, color or 16 bit
- Sound card w/speakers
- Microphone and recording software
- Keyboard & mouse
- Most current version of Google Chrome, Safari or Firefox

*Smartphone, Google Chrome books and Android tablets may not be supported. iPads are the only tablets supported.

Note: Be sure to enable Java & pop-ups in the Web browser preferences

Participants should have a basic proficiency of the following computer skills:

- Sending and receiving emails
- A working knowledge of the Internet
- Microsoft Word (or a program convertible to Word)
- Acrobat PDF Reader
- Windows or Mac OS
- Video conferencing software

Netiquette (online etiquette)

Students are expected to participate in all discussions and virtual classroom chats as directed. Students are to be respectful and courteous to others on discussions boards. Foul or abusive language will not be tolerated. Do not use ALL CAPS for communicating to others AS IT CAN BE INTERPRETED AS YELLING. Avoid slang terms such as "wassup?" and texting abbreviations such as "u" instead of "you." Limit and possibly avoid the use of emoticons. Be cautious when using humor or sarcasm as tone is sometimes lost in an email or discussion post and the message might be taken seriously or sound offensive.

Video Conferencing Etiquette

When using Zoom, WebEx or other video conferencing tools, confirm the visible area is tidy, clear of background clutter, inappropriate or offensive posters, and other distractions. Ensure you dress appropriately and avoid using high traffic or noisy areas. Stay muted when you are not speaking and avoid eating/drinking during session. Before class session begins, test audio, video and lighting to alleviate technology issues.

Technical Support

Students should go to the [Password Reset Tool](#) if they have password issues. The page will provide instructions for resetting passwords and contact information if login issues persist. For other technical questions regarding eCourses, call the Center for Instructional Innovation and Technology Services (CIITS) at 936-261-3283 or email ciits@pvamu.edu.

Communication Expectations and Standards

Emails or discussion postings will receive a response from the instructor, usually in less than 48 hours. Urgent emails should be marked as such. Check regularly for responses.

Discussion Requirement

Online courses often require minimal to no face-to-face meetings. However, conversations about the readings, lectures, materials, and other aspects of the course can take place in a seminar fashion. This will be accomplished by the use of the discussion board. The exact use of discussion will be determined by the instructor.

It is strongly suggested that students type their discussion postings in a word processing application such as Word and save it to their PC or a removable drive before posting to the discussion board. This is important for two reasons: 1) If for some reason your discussion responses are lost in your online course, you will have another copy; 2) Grammatical errors can be greatly minimized by the use of the spell-and-grammar check functions in word processing applications. Once the post(s) have been typed and corrected in the word processing application, copy and paste to the discussion board.

COVID-19 Campus Safety Measures [NOTE: Delete this section when the COVID-19 pandemic is over]

To promote public safety and protect students, faculty, and staff during the COVID-19 pandemic, Prairie View A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring** - Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.
- **Face Coverings** - Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain.
- **Physical Distancing** - Physical distancing must be maintained between students, instructors, and others in course and course-related activities.

- **Classroom Ingress/Egress** - Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Students should leave classrooms promptly after course activities have concluded, should not congregate in hallways and should maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
- **Face-to-face Class** - To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Office for Student Conduct for adjudication. Additionally, the faculty member may choose to teach that day's class remotely for all students.
- **COVID-19 Guidelines for Student Conduct Adjudication** - The mandatory COVID-19 Training/Certification taken by all students serves as the 1st Warning for violation of COVID-19 Guidelines.
 - 1st incident: upon review of Incident Report and finding of responsibility — Conduct Probation
 - 2nd incident: upon review of Incident Report and finding of responsibility — Suspension
 - Consult the Code of Student Conduct in the Student Planner or [Student Conduct website](#) for additional information on Conduct Probation and Suspension.

Personal Illness and Quarantine - Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities. Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence. To receive an excused absence, students must provide appropriate documentation to the Office for Student Conduct, studentconduct@pvamu.edu.

End of Semester Course Assessment Report

This summary contains the following Information

1. Performance Statistics

- Total number of students in class
- The class average performance (**stated as %**) in each course outcome assessed in this class and the **two previous times course was assessed**.
- The acceptable class average for the class in each outcome area as set by your Department. **You cannot use any number of your choice**
- Percentage of students who scored below the expected average in each outcome.

2. Implementation Summary

- Brief summary of plans implemented during the semester based on last assessment report

3. Perceived Problems

- Instructor's **critical evaluation** of perceived problems that affected students' performance. **Realistic problems should be identified throughout the semester and summarized in this section of the report.**

4. New Plans for Addressing Problems

- Instructor's plans for addressing the perceived problems the next time the class is taught. **These should be specific enough for another instructor to implement. Most of these should be things that, you, the instructor can implement to help students to improve. Be creative.**

5. Overall Trend over last three assessment periods

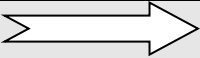
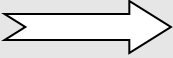
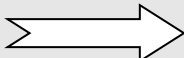
- Instructors summary of overall performance trend for each outcome measured over the last three periods.

5. Were Expectations Met?

- Answer **YES** if the **class average was above the expected average** and the **stated percentage of students** scored at or above the expected average, else answer **NO**.

Table 1. END OF SEMESTER COURSE OUTCOME ASSESSMENT REPORT
CHEG 3023 Unit Operations
Fall 2020 SEMESTER

Report Prepared by: Dr. Keisha Antoine Report Date: December 20, 2020

Semester	Analysis Type	Number of Students	Outcome 2 (old Outcome e) Ability to apply knowledge of mathematics, science, & engineering				Outcome 7 (old Outcome i) Ability to recognize the need for and the ability to engage in life long learning			
			Expected Average	Expected Percent of students at or above average	Class Average	% Students Above Expected Average	Expected Average	Expected Percent of students at or above average	Class Average %	% Students Above Expected Average
Fall 2020	Direct	24	75	70	76.4	58	75	70	76.4	58
Fall 2019	Direct	20	75	70	78	65	75	70	86	95
Fall 2018	Direct	28	75	70	71	65	75	70	90	100
Fall 2017	Direct	35	75	70	68	58	75	70	86	100
Fall 2016	Direct	35	75	70	75	54	75	70	90	97
Fall 2015	Direct	25	75	70	80	87	75	70	92	100
Implementation Summary			Review problems were given for each topic and most of them were solved in class. Instructor gave in-class activity and group assignments. Homework score as % of grade was increased from 5% to 10% and submission was mandatory, to incentivize learning. Concepts of continuity and Bernoulli equation were taught with the aid a lab project done in groups. Scheduled office hours were provided to address student issues.				A group project was given to the students related to practical issues so that they can visualize the problems. Some concepts were challenging for the students to visualize – viscosity, film thickness and choosing the endpoints for use in the Bernoulli equation. The lab assignments and the group work helped to fix a lot of these concepts for them.			
Perceived Problems			Students had difficulty conceptualizing the relationship between head and pressure. Hybrid classes made necessary by COVID-19 may have posed an issue for some students. Unit conversions is still an area of concern, but their ability is improving. “Collaboration” during exams which are not proctored.				Students had issues to conceptualize the relationship between head and pressure. Unit conversions is still an area of concern, but their ability is improving. Hybrid classes made necessary by COVID-19 may have posed an issue for some students. “Collaboration” during exams which are not proctored.			
Plans for Addressing Problems			Increasing the homework contribution to the overall grade and requiring submission of the homework. Demonstrate examples of collaboration to students with examples of their own work to encourage them to submit their own work.				Hybrid classes are expected in the Spring semester. Continue to provide students with actual data of laboratory experiments to expose them to scenarios related to fluid dynamics which can help them to understand better.			
Overall Trend over Periods			The class average is greater than the target of 75% as with last cohort, however, the number of students above the average decreased and was below the target of 70%.				The class average is greater than the target of 75% as with last cohort, however, the number of students above the average decreased and was below the target of 70%.			
Were Expectations Met?	Average ≥ 75%? 70% students avg. ≥ 75%?		NO				NO			

**Grade Sheet Showing
Student and Class Performance in Outcomes
The computed semester average in each outcome
as stated in the Assessment report are
highlighted in boldface**

Grade Sheet Showing Student and Class Performance in Course Outcomes

CHEG 3023 Unit Operations, FALL 2020 Semester

ABET Outcomes	2.1: Ability to Define/Understand the Problem and then Plan the Project			7.1: Acquire new knowledge using the appropriate learning strategies 7.2: Apply new knowledge to solve problems.		
Assignment	T2-Bernoulli Group- 11/19/2020	Final-12/4/2020	Composite (2.1)	T2-Bernoulli Group- 11/19/2020	Final-12/4/2020	Average (7.1, 7.2)
Class Average per Assignment	70.8	81.9	76.4	70.8	81.9	76.4
Maximum Points	100	100	100.0	100	100	100.0
1	50.6	64.5	57.6	50.6	64.5	57.6
2	63.3	87	75.1	63.3	87	75.1
3	96.3	55	75.7	96.3	55	75.7
4	61.6	67	64.3	61.6	67	64.3
5	84.9	67.5	76.2	84.9	67.5	76.2
6	50.6	85	67.8	50.6	85	67.8
7	63.3	95	79.1	63.3	95	79.1
8	96.3	93	94.7	96.3	93	94.7
9	61.6	91	76.3	61.6	91	76.3
10	84.9	87.5	86.2	84.9	87.5	86.2
11	50.6	94	72.3	50.6	94	72.3
12	63.3	92	77.6	63.3	92	77.6
13	96.3	89.5	92.9	96.3	89.5	92.9
14	61.6	74.0	67.8	61.6	74.0	67.8
15	84.9	83.5	84.2	84.9	83.5	84.2
16	50.6	83.5	67.1	50.6	83.5	67.1
17	63.3	85.0	74.1	63.3	85.0	74.1
18	96.3	100.0	98.2	96.3	100.0	98.2
19	61.6	62.0	61.8	61.6	62.0	61.8
20	84.9	88.0	86.4	84.9	88.0	86.4
21	50.6	71.0	60.8	50.6	71.0	60.8
22	63.3	63.0	63.1	63.3	63.0	63.1
23	96.3	93.0	94.7	96.3	93.0	94.7
24	61.6	95.5	78.6	61.6	95.5	78.6
ABET Outcome 2.1	Class Average		76.4	ABET Outcome 7.1, 7.2	Class Average	76.4
	Class Std Deviation		11.6		Class Std Deviation	11.6
	Class Average (%)		76.4		Class Average (%)	76.4
	No. of students > Expected Class Average (75%)		14		No. of students > Expected Class Average	14
	% of Students > Class Average		58		% of Students > Class Average	58

**OUTCOME SPECIFIC ASSIGNMENTS
USED TO ASSESS OUTCOMES**

(Provide at least two assignments used to specifically measure each outcome and justify the suitability of the assignments for the outcome being measured)

ASSIGNMENTS FOR OUTCOME 2

Ability to Define/Understand the Problem and then Plan the Project

ASSIGNMENTS FOR OUTCOME 7

An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

**CHEMICAL ENGINEERING
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
CHEG 3023 UNIT OPERATIONS
FALL 2020**

Instructor: Dr. Keisha Antoine

Title of Assignment

Final Exam 12/4/2020

Outcome Measured Using this Assignment

Outcome 2

An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factor

Check the engineering design characteristics related to this assignment

X	Involves identifying the specific needs to be met by defining/understanding the problem and developing plans for the project to satisfy the need
	Involves conducting a review of the literature and performing preliminary design by generating alternative ideas/solutions and applying creativity
	Involves performing detailed engineering design leading to specification and fabrication/selection of components for system being designed.
	Involves consideration of one or more of the following (Please check those involved in this assignment.)
	Public health
	Safety and welfare
	Global factors
	Cultural factors
	Social factors
	Environmental factors
	Economic factors
	Involves fabrication and testing of model or prototype

Brief justification of why this assignment is suitable for this outcome

The final exam is a comprehensive exam evaluating concepts of continuity, mechanical energy balance and hydrostatics. Pump work is also evaluated.

**CHEMICAL ENGINEERING
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
CHEG 3023 UNIT OPERATIONS
FALL 2020
Instructor: Dr. Keisha Antoine**

Title of Assignment

Final Exam 12/4/2020

Outcome Measured Using this Assignment

Outcome 7

An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Check the outcome characteristics related to this assignment

Ability to Acquire new knowledge using the appropriate learning strategies Requires students to:	
x	Be knowledgeable of and use different learning strategies (<i>Instructor may provide information on different learning strategies</i>)
x	Identify and take advantage of learning opportunities available in the library, online resources, seminars, webinars, conferences, workshops and tutorials.
x	Be aware of the need for and are able to independently acquire additional knowledge and data needed for solving problem using appropriate learning strategies and tools.
Ability to apply new knowledge to solve problems Requires students to:	
x	Demonstrate appropriate use of the new knowledge to solve problems.

Brief justification of why this assignment is suitable for this outcome

The final exam is a comprehensive exam evaluating concepts of continuity, mechanical energy balance and hydrostatics. Pump work is also evaluated.

CHEG 3023 Y02 FINAL EXAM

Dear CHEG 3023 Y02 Class,

This is the FINAL EXAM. This 2-hour exam is OPEN BOOK, OPEN NOTES. You are being tested on all the material covered from chapters 1-4 and part of chapter 8 of the text. There are SEVEN (7) questions. You will need to upload Questions 6 and 7 of this test.

Question 1-4: 5 points each

Question 5: 10 points (type your responses directly in the window)

Questions 6: 30 points (upload your response to this question)

Question 7: 40 points (upload your responses to this question)

Honor system

This is an individual assessment of your knowledge up to this point, therefore, no collaboration is allowed.

1. A vessel is initially connected to a reservoir open to the atmosphere. The connecting valve is then closed, and a vacuum of 65.5 kPa is applied to the vessel. What is the absolute pressure in the vessel? Assume standard atmospheric pressure. [5 points]

- a. 36 kPa
- b. 66 kPa
- c. 86 kPa
- d. 110 kPa

2. What height of mercury column is equivalent to a pressure of 700 kPa? The density of mercury is 13,500 kg/m³. [5 points]

- a. 0.75 m
- b. 1.5 m
- c. 3.4 m
- d. 5.3 m

3. What is the head loss for water flowing through a horizontal pipe if the gage pressure at point 1 is 1.03 kPa, the gage pressure at point 2 downstream is 1.00 kPa, and the velocity is constant? [5 points]

- a. 3.1×10^{-3} m
- b. 3.1×10^{-2} m
- c. 2.3×10^{-2} m
- d. 2.3 m

4. What horizontal force is required to hold the plate stationary against the water jet? (All of the water leaves parallel to the plate.) [5 points]

- a. 17.7 N
- b. 35.4 N
- c. 42.2 N
- d. 67.5 N

5. What is the viscosity of brine, NaCl, 25% at 300°F. Give your answer in cP. Make sure to state how you obtained your information. [10 points]

6. A horizontal venturi meter having a throat diameter of 15 mm is set in a schedule 40, 3 ½ in. pipe. Water at 20°C is flowing through the line. A manometer containing mercury under water measures the pressure differential over the instrument. When the manometer reading is 425 mm, what is flow rate in gal/min? [30 points]

Sketch 3

Diameter of Sch 40, 3.5 in pipe using Appendix 3

Appropriate equation to calculate delta P – Rm, density Hg, density water 10

Calculate flow rate – calculate beta, cross-sectional area, Cv 7

Unit conversion 5

Correct units 2



7. Water at 20°C is pumped at a constant rate of 9 m³/h from a large reservoir resting on the floor to the open top of an experimental absorption tower. The point of discharge is 5 m above the floor, and friction losses in the 50-mm pipe from the reservoir to the tower amount to 2.5 J/kg. At what height in the reservoir must the water level be kept if the pump can deliver only 0.1 kW? [40 points]

1. Sketch w/ a and b 2

2. Mechanical energy balance w/ simplifying assumptions 15

3. Find W_p from Power, and mass flowrate 15

4. Calculate Z_a 5

5. Unit conversion 2

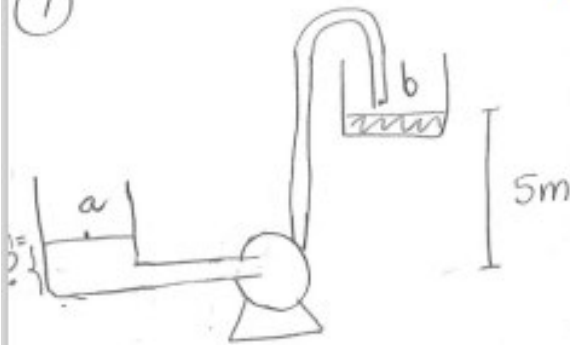
6. Correct answer 1

)

Sample of student's graded solution

⑦

100/100



$$h_f = 2.5 \text{ J/kg} = 2.5 \text{ m}^2/\text{s}^2$$

$$P = 0.1 \text{ kW} = \frac{0.1 \text{ kJ}}{\text{s}} \times \frac{3600 \text{ s}}{1 \text{ h}} = 360 \text{ kJ/h}$$

Choose efficiency of the pump is 100%

$$V = 9 \text{ m}^3/\text{h}$$

Bernoulli equation :

$$\frac{P_a}{\rho} + gz_a + \frac{\alpha_a \bar{V}_a^2}{2} + W_p = \frac{P_b}{\rho} + gz_b + \frac{\alpha_b \bar{V}_b^2}{2} + h_f$$

- Point a is at the surface of water in the large reservoir

- Point b at the discharge point

- Both is at atmospheric pressure $\rightarrow P_a = P_b$

- $z_a = h$: need to find

- $z_b = 5 \text{ m}$

- $\alpha_a = \alpha_b = 1$: assume turbulent flow

- Area of the reservoir is larger than area of the discharge pipe ($A_a \gg A_b$) $\Rightarrow V_a$ is negligible $\Rightarrow V_a \approx 0$

$$\Rightarrow gh + W_p = 5g + \frac{V_b^2}{2} + h_f$$

1. Sketch w/ a and b 2/2

2. Mechanical energy balance w/ simplifying assumptions 15/15

3. Find W_p from Power, and mass flowrate 15/15

4. Calculate z_a 5/5

5. Unit conversion 2/2

6. Correct answer 1/1

Pipe: 50 mm $\Rightarrow d = 0.05 \text{ m} \Rightarrow A_b = \frac{\pi d^2}{4} = \frac{\pi (0.05)^2}{4} = 1.9635 \times 10^{-3} \text{ m}^2$

Mass continuity: water leaving the reservoir = water into the tower

Flow rate $q = v_b A_b$

$$\Rightarrow 9 \text{ m}^3/\text{h} = v_b (1.9635 \times 10^{-3} \text{ m}^2)$$

$$\Rightarrow v_b = 4583.65 \text{ m/h} \times \frac{1 \text{ h}}{3600 \text{ s}} = 1.273 \text{ m/s}$$

Mass flow rate: $m = \rho q = (1000 \text{ kg/m}^3) (9 \text{ m}^3/\text{h}) = 9000 \text{ kg/h}$

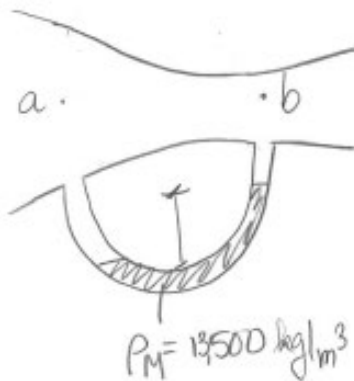
$$W_p = \frac{360 \text{ kJ/h}}{9000 \text{ kg/h}} \times \frac{10^3 \text{ J}}{1 \text{ kJ}} = 40 \text{ J/kg} = 40 \text{ m}^2/\text{s}^2$$

Equation $\Rightarrow$

$$\left(9.8 \frac{\text{m}}{\text{s}^2}\right) h + 40 \frac{\text{m}^2}{\text{s}^2} = (5 \text{ m}) \left(9.8 \frac{\text{m}}{\text{s}^2}\right) + \frac{(1.273 \text{ m/s})^2}{2} + 2.5 \frac{\text{m}^2}{\text{s}^2}$$

$$\rightarrow h = \boxed{1.256 \text{ m}}$$

⑥



$d_{throat} = 15 \text{ mm}$ schedule 40, $3\frac{1}{2}$ in
Water, $T_1 = 20^\circ\text{C}$ 3.548 in

$$P_a > P_b$$

$$P_{water} = 1000 \text{ kg/m}^3$$

$$R_m = 425 \text{ mm}$$

$$\text{schedule 40, } 3\frac{1}{2} \text{ in pipe, ID} = 3.548 \text{ in} \times \frac{1 \text{ m}}{39.37 \text{ in}} = 0.0912 \text{ m} = 90.12 \text{ mm}$$

$$\Rightarrow d_a = 90.12 \text{ mm} \quad d_b = 15 \text{ mm}$$

$$\Delta P = P_a - P_b = \rho R_m (P_A - P_B) \quad \text{where } P_A = P_M$$

$$P_B = P_{water}$$

$$= 9.8 \text{ m/s}^2 (425 \times 10^{-3} \text{ m}) (13,500 \text{ kg/m}^3 - 1000 \text{ kg/m}^3)$$

$$= 52,062.5 \text{ kg/m.s}^2 = 52,062.5 \text{ Pa}$$

Bernoulli equation without friction:

$$\frac{P_a}{\rho_w} + gZ_a + \frac{u_a^2}{2} = \frac{P_b}{\rho_w} + gZ_b + \frac{u_b^2}{2}$$

Sketch 3/3

Diameter of Sch 40, 3.5 in pipe using Appendix 3/3

Appropriate equation to calculate $\Delta P - R_m$, density Hg, density water 10/10

Calculate flow rate -

calculate beta, cross-sectional area, Cv 7/7

Unit conversion 5/5

Correct units 2/2

Assume no friction

- Elevation at point a and b are the same $\Rightarrow z_a \approx z_b$

$$\Rightarrow \frac{P_a}{\rho_w} + \frac{u_a^2}{2} = \frac{P_b}{\rho_w} + \frac{u_b^2}{2} \quad (1)$$

Mass continuity: $\dot{m} = \rho u_a S_a = \rho u_b S_b$

$$\Rightarrow \frac{u_a}{u_b} = \frac{S_b}{S_a} = \frac{d_b^2}{d_a^2} = \frac{(15 \times 10^{-3} \text{ m})^2}{(90.12 \times 10^{-3} \text{ m})^2}$$
$$= 0.0277$$

$$\Rightarrow u_a = 0.0277 u_b$$

Substitute into equation (1)

$$\frac{P_a}{\rho_w} + \frac{(0.0277 u_b)^2}{2} = \frac{P_b}{\rho_w} + \frac{u_b^2}{2}$$

okay

$$\Rightarrow \frac{P_a - P_b}{\rho_w} = \frac{1 - (0.0277)^2}{2} u_b^2$$

$$\Rightarrow \frac{52,062.5 \text{ kg/m.s}^2}{1000 \text{ kg/m}^3} = 0.4996 u_b^2$$

$$\Rightarrow u_b^2 = 104.21$$

$$\Rightarrow u_b = 10.2 \text{ m/s}$$

$$\begin{aligned}
 \text{Flow rate } q &= u_b S_b = (10.2 \text{ m/s}) \left(\frac{\pi (15 \times 10^{-3} \text{ m})^2}{4} \right) \\
 &= 1.8 \times 10^{-3} \frac{\text{m}^3}{\text{s}} \times \frac{264.17 \text{ gal}}{1 \text{ m}^3} \times \frac{60 \cancel{\text{s}}}{1 \text{ min}} \\
 &= \boxed{28.53 \text{ gal/min}}
 \end{aligned}$$

**CHEMICAL ENGINEERING
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
CHEG 3023 UNIT OPERATIONS
FALL 2020**

Instructor: Dr. Keisha Antoine

Title of Assignment

T2-Understanding Bernoulli Principle 11/19/2020

Outcome Measured Using this Assignment

Outcome 2

An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factor

Check the engineering design characteristics related to this assignment

X	Involves identifying the specific needs to be met by defining/understanding the problem and developing plans for the project to satisfy the need
	Involves conducting a review of the literature and performing preliminary design by generating alternative ideas/solutions and applying creativity
	Involves performing detailed engineering design leading to specification and fabrication/selection of components for system being designed.
	Involves consideration of one or more of the following (Please check those involved in this assignment.)
	Public health
	Safety and welfare
	Global factors
	Cultural factors
	Social factors
	Environmental factors
	Economic factors
	Involves fabrication and testing of model or prototype

Brief justification of why this assignment is suitable for this outcome

This assignment allows the students to gain fundamental understanding of the Bernoulli Principle across pipes, fittings and a centrifugal pump. Students are responsible for data collection and

**CHEMICAL ENGINEERING
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
CHEG 3023 UNIT OPERATIONS
FALL 2020
Instructor: Dr. Keisha Antoine**

Title of Assignment

T2-Understanding Bernoulli Principle 11/19/2020

Outcome Measured Using this Assignment

Outcome 7

An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Check the outcome characteristics related to this assignment

Ability to Acquire new knowledge using the appropriate learning strategies Requires students to:	
x	Be knowledgeable of and use different learning strategies (<i>Instructor may provide information on different learning strategies</i>)
x	Identify and take advantage of learning opportunities available in the library, online resources, seminars, webinars, conferences, workshops and tutorials.
x	Be aware of the need for and are able to independently acquire additional knowledge and data needed for solving problem using appropriate learning strategies and tools.
Ability to apply new knowledge to solve problems Requires students to:	
x	Demonstrate appropriate use of the new knowledge to solve problems.

Brief justification of why this assignment is suitable for this outcome

This assignment allows the students to gain fundamental understanding of the Bernoulli Principle across pipes, fittings and a centrifugal pump by deriving final equation forms.

CHEG 3023 Y02 T2-Understanding Bernoulli Principle-11/19/2020

Instructions

Groups will be assigned. Max of 5 students per group. Turn in group assignment on November 16, 2020.

Objective

In this assignment, students will study the principle of mechanical energy conservation (Bernoulli Principle) using Edibon PBCC Centrifugal Pump and the Venturi meter located on the Edibon AFT-B Fluid Friction in Pipes Equipment.

Edibon PBCC Centrifugal Pump

The program measures pump speed in rpm, pressure at the suction, $P_{suction}$ (bar), pressure at the discharge, $P_{discharge}$ (bar), torque, M (N.m), flow rate, Q (L/min), total head, H_t (m), mechanical energy of the pump, W_p . Disregard the values for pressures that the program records in carrying out these exercises.



Resources

- UOCE, 7th Ed., Chapter 4, Mechanical Energy Equation (pp 86 – 94), Ex. 4.6, Prob. 4.4; Chapter 8, Centrifugal Pumps (pp 208 – 209), Ideal Pump (pp 210), Actual pump performance (211 – 212), Ex. 8.1
- Chapter 4c class notes (available on eCourses)

Instructions

- Data have been provided for you for your use in completing the exercises. Please see data packet.
- You will first determine the pressure drop developed by the pump for various volumetric flow rates. This step is required to answer question 3 of the Exercises.
 - The experiment was run using the Edibon PBCC in Gilchrist Room 127.
 - The experiment was conducted for various openings of the discharge valve (a minimum of 4 readings of the volumetric flow rate, Q). The data was recorded for use in Exercise 3.

Exercises

- Using Bernoulli's principle,
 - Estimate the velocity of discharge of the tank. [25 points]
 - Estimate the time to completely empty the tank. Diameter of discharge tube from tank is equal to the diameter of the pipe feeding to the tank. [25 points]

State your assumptions.

- Use Bernoulli's principle to derive total head, H_t in meters. [20 points]

- Assuming the value of H_t measured by the software is correct and using a to represent the suction point and b to represent the discharge point, calculate the pressure developed by the pump, ΔP . State your assumptions. [50 points]

Venturi meter in Edibon AFT-B Fluid Friction in Pipes

$D_{pipe} = 26.5$ mm

Resources

- UOCE, 7th Ed., Chapter 4, Mechanical Energy Equation (pp 86 – 94); Chapter 8, Venturi Meter (pp 225 – 227)
- Chapter 4c class notes (available on eCourses)

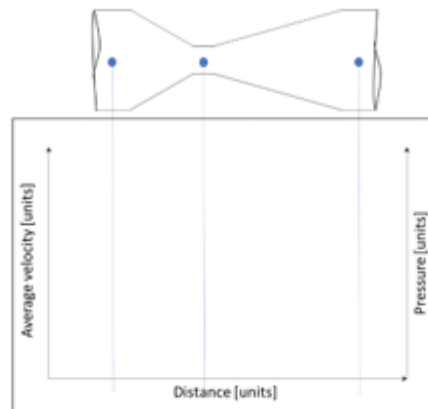
Instructions

- Data have been provided for you for your use in completing the exercises. Please see data packet.
- The pressures for the entrance, throat and downstream tap were measured for 4 readings of volumetric flow rate (replicates were taken of each data point)
 - Calculate the pressure drops (see data packet for AFT-B Venturi tab) [20 points]

Flow rate, Q [units?]	$P_{entrance}$ [units?]	P_{throat} [units?]	ΔP (entrance→throat) [units?]	P_{exit} [units?]	ΔP (entrance→exit) [units?]

Exercises

- How does the pressure vary with distance in the venturi meter as the flow moves from the large diameter to the small diameter? From the small diameter to the large diameter? Show the variation of pressure vs. distance in the flow direction on a graph. [20 points]
- How does the velocity vary with distance in the venturi meter as the flow moves from the large diameter to the small diameter? From the small diameter to the large diameter? Show the variation of average velocity vs. distance in the flow direction on a graph. [20 points]



3. Use the Bernoulli equation to explain the graphs of pressure and velocity vs. distance in going from:
 - a. Entrance to throat [10 points]
 - b. Throat to exit [10 points]Assume no frictional losses.
4. The pressure loss between the two ends of the venturi meter should be far less than the pressure drop between the entrance and throat of the venturi. Explain why this is the case. [10 points]
5. Find the diameter of the throat. [25 points]
6. Describe how venturi meters are used in industry [10 points]

Sample of student's graded solution

236/245



Course Name: CHEG 3023 - Unit Operations

Group Members

Anh Nguyen

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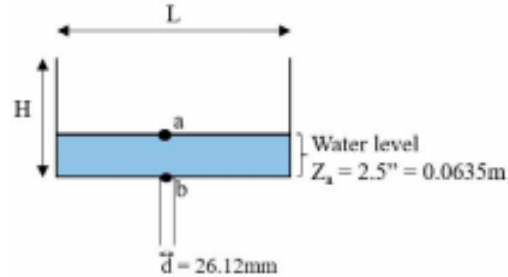
Instructor: Dr. K. Antoine

Test 2 - Understanding Bernoulli Principle

Edibon PBCC Centrifugal Pump

1. Assumptions:

- Datum level is at the point of discharge, $Z_b = 0$.
- Both pressures at point a and b are at atmospheric pressure (1.01325×10^5 Pa).
- Surface area of the tank is a lot larger than the area of the discharge pipe; therefore the velocity of point a u_a is negligible, $u_a \approx 0$.
- Density of water $\rho = 1000 \text{ kg/m}^3$; nearly incompressible.



- a, The elevation of water is point a, $Z = 2.5'' = 0.0635\text{m}$.
Discharge velocity $u_b = 1.12 \text{ m/s}$.

- b. Tank is full, which has the height: $H_0 = 11.75'' = 0.29845\text{m}$.
Time required to empty the tank is $t = 1.88 \text{ min}$

Bernoulli with W_p and h_f 8/10
Sketch 10/10
Choice of a and b 5/5
Simplifying assumptions 5/5
Appropriate final equation to solve 6/6, 6/6
Correct values for variables 3/3, 2/3
Correct ans 1/1, 1/1

2. $H_t = \eta W_p = \frac{P_a - P_b}{\rho g} \text{ (m)}$

3. Assumptions:

- Point a: suction point, point b: discharge point.
- Friction loss (h_f) is negligible because we are at two points across the pump, so any friction loss is taken care of by the efficiency of the pump.
- Contribution of kinetic energy is small compared to pressure term.
- Elevation between point a and b is negligible.
- Density of water $\rho = 1000 \text{ kg/m}^3$; nearly incompressible

Result: Pressure developed ΔP

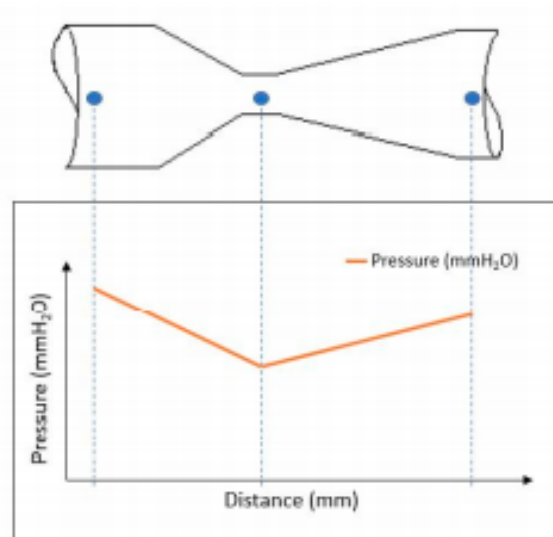
- Fully open: $91 \text{ kPa} = 0.91 \text{ bar}$
- 25% closed: $97.4 \text{ kPa} = 0.974 \text{ bar}$
- 50% closed: $111.4 \text{ kPa} = 1.114 \text{ bar}$
- 75% closed: $131.2 \text{ kPa} = 1.312 \text{ bar}$
- Fully closed: $209.2 \text{ kPa} = 2.092 \text{ bar}$

Venturi meter in Edibon AFT-B Fluid Friction in Pipes

Table:

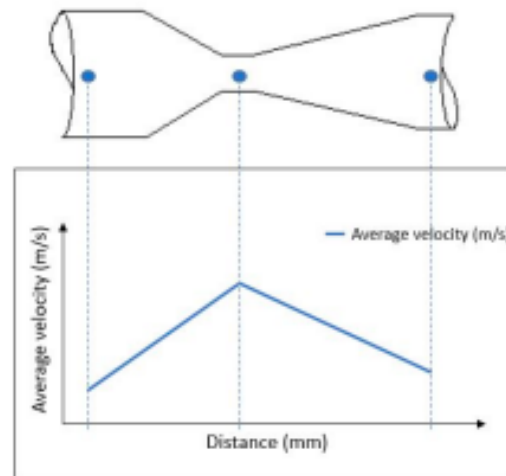
Flow rate Q (L/h)	P_{entrance} (mmH ₂ O)	P_{throat} (mmH ₂ O)	$\Delta P_{\text{entrance-throat}}$ (mmH ₂ O)	P_{exit} (mmH ₂ O)	$\Delta P_{\text{entrance-exit}}$ (mmH ₂ O)
1800	180	98	82 ¹⁰	175	5 ¹⁰
2000	218	130	88	205	13
2600	305	170	135	280	25
3000	368	198	170	330	38

1. Pressure vs. Distance: As the flow moves from the large diameter to the small diameter, the pressure drops. As the flow moves from the small diameter to the larger one, the pressure increases.



20/20

2. Average velocity vs. Distance: As the flow moves from the large diameter to the small diameter, the average velocity increases. As the flow moves from the small diameter to the larger one, the average velocity decreases.



20/20

3. Equations:

Bernoulli equation expresses the relation between the rate of flow velocity and the pressure and the greater the fluid flow speed within the lower pressure.

$$\frac{P_1}{\rho g} + h_1 + \frac{v_1^2}{2g} = \frac{P_2}{\rho g} + h_2 + \frac{v_2^2}{2g}$$

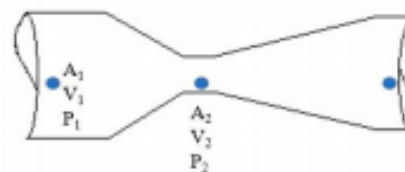
In venturi meter specifically, $h_1 = h_2 \Rightarrow \frac{P_1}{\rho g} + \frac{v_1^2}{2g} = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} \Rightarrow v_2^2 - v_1^2 = \frac{2(P_1 - P_2)}{\rho g} \quad (1)$

Flow rate: $Q = v_1 A_1 = v_2 A_2$

a: From entrance to throat: Flow rate is constant from the entrance to the throat, and the area of the throat, A_2 , is smaller than the area of the entrance, A_1 ($A_2 < A_1$). Therefore, the velocity at throat v_2 is larger than the velocity at entrance v_1 ($v_2 > v_1$). Through Bernoulli's equation, we see that $v_2 > v_1$ (left side of equation 1 is positive), so $P_1 > P_2$, which means pressure at the throat is smaller than pressure at the entrance. Thus, as it's flowing from the entrance to the throat, the pressure is decreasing while the average velocity is increasing.

8/10

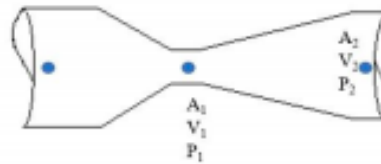
yes, but need to mention explicitly that this behavior shows conservation of total energy



$$b: A_2 < A_1 \Rightarrow v_1 > v_2 \Rightarrow P_1 < P_2$$

From throat to exit: The upstream area (A_1) is smaller therefore the downstream area (A_2) is bigger ($A_1 < A_2$), so velocity at the throat v_1 is greater than velocity at the exit v_2 . Using Bernoulli's equation, we see that $v_1 > v_2$ (left side of equation 1 is negative), so $P_1 < P_2$, which means pressure at the throat is smaller than the pressure at the exit. Thus, as it's flowing from the throat to the exit, the pressure is increasing while the average velocity is decreasing.

8/10



4. The pressure drop between the entrance and the exit will be much smaller than the pressure drop between the entrance and the throat because the average velocities of the entrance and the exit are closer than the average velocities of the entrance and the throat, which would make the pressure difference between the entrance and the exit much smaller than the pressure difference between the entrance and the throat. Shortly, using Bernoulli equation, the change in velocity between the entrance and exit is small, so the pressure drop is small while the change in velocity between the entrance and throat is large making the pressure drop large. Also, the pressure drop between entrance and exit is small because the venturi meter is designed to recover as much energy as possible of the fluid.
5. Throat diameter: $d = 20.745\text{mm}$
6. Venturi meters are flow measuring instruments which are able to use a converging section of a pipe to increase and measure the flow in velocity of a corresponding pressure drop, from which flow rates can be deduced. The most common use of venturi meters can be found in processing units and the water supply, oil, and paper and pulp industry. For example, in the water supply industry, venturi meters are used to reduce the pressure drop during transportation and to save cost. When using a venturi meter during transportation, the velocity of water is increased and pressure is decreased at the throat. Then pressure is mostly recovered from its initial pressure to consumers. Fuel injectors and jet pumps also play a role with the venturi effect. As the fluid with the high speed enters the smaller cross-section, it begins to create a vacuum and gives momentum to the other fluids.

8/10

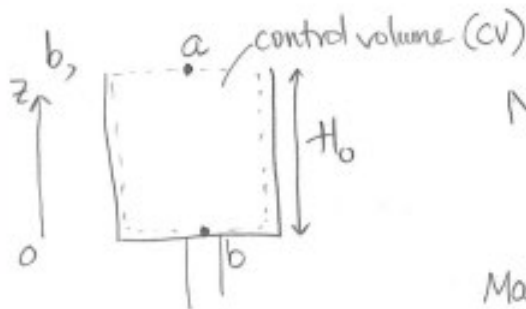
10/10

Pump

1.
$$a, \frac{p_a}{\rho} + gz_a + \frac{u_a^2}{2} = \frac{p_b}{\rho} + gz_b + \frac{u_b^2}{2}$$
 missing eff. Wp, hf

$$\Rightarrow u_b = \sqrt{2gz_a} = \sqrt{2(9.8 \text{ m/s}^2) \left(2.5 \text{ in} \times \frac{1 \text{ m}}{39.37 \text{ in}} \right)}$$

$$= 1.1156 \text{ m/s} \approx \boxed{1.12 \text{ m/s}}$$



No mass enters the control volume, $\dot{m}_{in} = 0$

$$\dot{m}_{in} - \dot{m}_{out} = \frac{dm_{cv}}{dt}$$

Mass leaving the tank through a pipe,

$$\dot{m}_{out} = \rho u_b A_{pipe} \text{ with } u_b = \sqrt{2gz_a}$$

$$A_{pipe} = \frac{\pi d^2}{4}$$

$$\Rightarrow \dot{m}_{out} = \rho \frac{\pi d^2}{4} \sqrt{2gz_a}$$

Mass of water in the tank at any time

$$m_{cv} = \rho V = \rho W L z_a \text{ with } W \text{ is width, } L \text{ is length}$$

As amount of water leaving the tank, only z_a is changing

$$\Rightarrow \frac{dm_{cv}}{dt} = \frac{d(\rho W L z_a)}{dt} = \rho W L \frac{dz_a}{dt}$$

$$-\dot{m}_{out} = \frac{dm_{cv}}{dt}$$

$$\Rightarrow -\rho \frac{\pi d^2}{4} \sqrt{2gz_a} = \rho WL \frac{dz_a}{dt}$$

$$\Rightarrow dt = \left(\frac{-4WL}{\pi d^2 \sqrt{2g}} \cdot \frac{1}{\sqrt{z_a}} \right) dz_a$$

Boundary Condition: $t=0, z_a=H_0$
 $t=t, z_a=0$

$$\text{Integration } t = -\frac{4WL}{\pi d^2 \sqrt{2g}} \int_{H_0}^0 z_a^{-1/2} dz_a$$

$$= -\frac{8WL\sqrt{z_a}}{\pi d^2 \sqrt{2g}} \Big|_{H_0}^0$$

$$= \frac{8WL\sqrt{H_0}}{\pi d^2 \sqrt{2g}}$$

$$= \frac{8(0.3937\text{m})(0.6223\text{m})\sqrt{0.29845\text{m}}}{\pi (0.02612\text{m})^2 \sqrt{2(9.8\text{m/s}^2)}}$$

$$= 112.84\text{ s} = \boxed{1.88\text{ min}}$$

$H=2.5\text{ in}$

$$W = 15.5\text{ in} \times \frac{1\text{m}}{39.37\text{in}} = 0.3937\text{m}$$

$$H = 11.75\text{ in} \times \frac{1\text{m}}{39.37\text{in}} = 0.29845\text{m}$$

$$L = 24.5\text{ in} \times \frac{1\text{m}}{39.37\text{in}} = 0.6223\text{m}$$

2.

- Bernoulli's Principle is applied to the passage of fluid within a control volume. Relates to the pressure, velocity, and height in fluid flow given at two points.

- Work performed on the fluid by centrifugal pump with discharge and suction point



Bernoulli with W_p and h_f 10/10
Simplifying assumptions 5/5
Appropriate final equation to solve 5/5

Mechanical energy balance equation

$$\frac{P_a}{\rho g} + \frac{v_a^2}{2g} + z_a + \eta W_p = \frac{P_b}{\rho g} + \frac{v_b^2}{2g} + z_b + h_f$$

$$\Rightarrow \eta W_p = \left(\frac{P_b}{\rho g} + \frac{v_b^2}{2g} + z_b \right) - \left(\frac{P_a}{\rho g} + \frac{v_a^2}{2g} + z_a \right) + h_c$$

$$\text{Head at suction: } H_{\text{suction}} = \frac{P_a}{\rho g} + \frac{v_a^2}{2g} + z_a$$

$$\text{Head at discharge: } H_{\text{discharge}} = \frac{P_b}{\rho g} + \frac{v_b^2}{2g} + z_b$$

$$\begin{aligned} \text{Total head: } H_t &= H_{\text{discharge}} - H_{\text{suction}} + h_f \\ &= \left(\frac{P_b}{\rho g} + \frac{v_b^2}{2g} + z_b \right) - \left(\frac{P_a}{\rho g} + \frac{v_a^2}{2g} + z_a \right) + h_f \end{aligned}$$

$$\Rightarrow \eta W_p = H_t$$

In case choosing a and b in the diagram:

$$+ z_a \approx z_b \Rightarrow z_a - z_b = 0$$

+ friction loss is taken care of by the pump efficiency, $h_f = 0$

+ kinetic energy term is small compared to pressure term

$$\Rightarrow H_t = \eta W_p = \frac{P_b - P_a}{\rho g} [=] \text{ m}$$

3. $\Delta P = \rho g H_t$

* Fully open: $H_{t, \text{avg}} = \frac{4.181557 + 9.361162 + 9.292306 + 9.317305}{4}$

Sketch 10/10

Choice of a and b 5/5

Simplifying assumptions 10/10

Head calculation 25/25

$$= 9.288 \text{ m}$$

$$\Delta P = \rho g H_t = (1000 \text{ kg/m}^3)(9.8 \text{ m/s}^2)(9.288 \text{ m})$$

$$= 91,022 \text{ kg/m.s}^2$$

$$= \boxed{91 \text{ kPa}}$$

Similarly, 25% closed: $H_{t, \text{avg}} = 9.942 \text{ m}$

$$\Delta P = (1000 \text{ kg/m}^3)(9.8 \text{ m/s}^2)(9.942 \text{ m}) = 97,432 \text{ kg/m.s}^2 = \boxed{97.4 \text{ kPa}}$$

50% closed: $H_{t, \text{avg}} = 11.3676 \text{ m}$

$$\Delta P = (1000 \text{ kg/m}^3)(9.8 \text{ m/s}^2)(11.3676 \text{ m}) = 111,402 \text{ kg/m.s}^2 = \boxed{111.4 \text{ kPa}}$$

75% closed: $H_{t, \text{avg}} = 13.3855 \text{ m}$

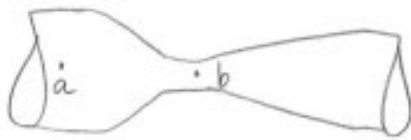
$$\Delta P = (1000 \text{ kg/m}^3)(9.8 \text{ m/s}^2)(13.3855 \text{ m}) = 131,178 \text{ kg/m.s}^2 = \boxed{131.2 \text{ kPa}}$$

Fully closed: $H_{t, \text{avg}} = 21.3466 \text{ m}$

$$\Delta P = (1000 \text{ kg/m}^3)(9.8 \text{ m/s}^2)(21.3466 \text{ m}) = 209,197 \text{ kg/m.s}^2 = \boxed{209.2 \text{ kPa}}$$

Venturi Meter:

5.



$$d_a = 26.5 \text{ mm} = 0.0265 \text{ m}$$

$$\alpha_a = \alpha_b = 1 \text{ : turbulent flow}$$

$$\rho_{\text{H}_2\text{O}} = 1000 \text{ kg/m}^3$$

$$\alpha_b \bar{V}_b^2 - \alpha_a \bar{V}_a^2 = \frac{2(P_a - P_b)}{\rho} \quad (8.22) \rightarrow \bar{V}_b^2 - \bar{V}_a^2 = \frac{2(P_a - P_b)}{\rho}$$

$$\bar{V}_a = \left(\frac{d_b}{d_a}\right)^2 \bar{V}_b \quad (8.23)$$

$$Q = \bar{V}_a A_a = \bar{V}_b A_b \text{ (continuity equation)}$$

Choosing to take the average of given data : flow rate (Q),

Pressure at entrance (P_a), Pressure at throat (P_b)

$$Q = \frac{1800 + 2000 + 2600 + 3000}{4} = 2350 \text{ L/h} \times \frac{1 \text{ m}^3}{10^3 \text{ L}} \times \frac{1 \text{ h}}{3600 \text{ s}}$$

$$= 6.5278 \times 10^{-4} \text{ m}^3/\text{s}$$

$$P_a = \frac{180 + 218 + 305 + 368}{4} = 267.75 \text{ mm H}_2\text{O} \times \frac{1.01325 \times 10^5 \text{ Pa}}{10.333 \text{ mm H}_2\text{O}} \times \frac{1 \text{ m H}_2\text{O}}{10^3 \text{ mm H}_2\text{O}}$$

$$= 2625.55 \text{ Pa}$$

$$P_b = \frac{98 + 130 + 170 + 198}{4} = 149 \text{ mm H}_2\text{O} \times \frac{1.01325 \times 10^5 \text{ Pa}}{10.333 \text{ mm H}_2\text{O}} \times \frac{1 \text{ m H}_2\text{O}}{10^3 \text{ mm H}_2\text{O}}$$

$$= 1461.089 \text{ Pa}$$

Velocity at entrance :

$$\bar{V}_a = \frac{Q}{A_a} = \frac{6.5278 \times 10^{-4} \text{ m}^3/\text{s}}{\frac{\pi (0.0265)^2}{4} \text{ m}^2} = 1.1835 \text{ m/s}$$

Velocity at throat

$$\begin{aligned}\bar{v}_b^2 &= \frac{2(P_a - P_b)}{\rho} + \bar{v}_a^2 \\ &= \frac{2(2625.55 - 1461.089) \frac{\text{kg m/s}^2}{\text{m}^2}}{1000 \frac{\text{kg}}{\text{m}^3}} + (1.1835 \text{ m/s})^2 \\ &= 3.7296 \text{ m}^2/\text{s}^2\end{aligned}$$

$$\Rightarrow \bar{v}_b = \sqrt{3.7296 \text{ m}^2/\text{s}^2} = 1.9312 \text{ m/s}$$

Diameter at throat

$$A_b = \frac{Q}{\bar{v}_b} = \frac{6.5278 \times 10^{-4} \text{ m}^3/\text{s}}{1.9312 \text{ m/s}} = 3.38 \times 10^{-4} \text{ m}^2$$

$$d_b = \sqrt{\frac{4A}{\pi}} = \sqrt{\frac{4(3.38 \times 10^{-4}) \text{ m}^2}{\pi}} \times \frac{10^3 \text{ mm}}{1 \text{ m}} = \boxed{20.745 \text{ mm}}$$

1. Find v_b 10/10
2. use continuity equation to find D_{throat} 10/10
3. Correct answer 5/5