Software Testing Project Report

1. An Overview of the Project

Introduction

The web application under testing is Java Web App for Employee Time Reporting.

The source code of the app can be found at following link:

http://www.java2s.com/Open-Source/Java_Free_Code/Web_Application/Download_timesheet_Free_Java_Code.htm

Overview of the application being tested

The project is a lighter version of a pay system for managing the time reporting of the employees.

Some of the application features are:

- Adding the new employees in the database and managing their roles.
- Time Logging for non-salaried employee (either by employee himself or by the admin)
- Configuring the database settings.
- Managing the groups in the company.
- Generate the ADP reports of the employees.

Black box Testing Contribution

Danish:

1. Setup and Run the web application, resolved all errors to run the project successfully.
2. Identified Use case 1,5,6,8 and wrote test cases for them.

Abu Bakar:

1. Compiled final reports for all submissions and submitted them.
2. Identified Use case 2,3,4,7 and wrote test cases for them.

Awais:

1. Use case 9,10,11 and wrote test cases for them.

Musa Khan:

No Contribution.

Environment Setup

The environment to run the application can be created by following these steps:

1. Download maven from here: https://maven.apache.org/download.cgi
2. Download and install the mysql workbench from here: https://dev.mysql.com/downloads/installer/
3. Download jdk1.8+
4. Clone https://github.com/risaldar/PaySystem
5. In the .\timesheet-master\build.bat, set the JAVA_HOME to jdk path and similarly set MAVEN_HOME to the maven path.
6. In the .\timesheet-master\run.bat, set the JAVA_HOME and set CATALINA_HOME to absolute path appended by ".\PaySystem\apache-tomcat-7.0.108-windows-x64\apache-tomcat-7.0.108".
7. Open Command prompt, navigate to project repository i.e .\Paysystem\timesheet-master\ and execute build.bat.

8. This will build the project.
9. Follow these steps for MySQL server

- Open ‘Run’ Window by using Win key + R
- Type ‘services.msc’
- Now search for MySQL service based on the version that is installed.
- Click on ‘stop’, ‘start’ or ‘restart’ the service option.

10. Open mysql workbench, start a new local connection, provide root user password (which is set at time of MySQL installation) and enter following two queries:

    DROP DATABASE paysystem;

    Create DATABASE paysystem;
11. When the database is created for first time, only execute the create query.
12. Execute run.bat.

Application Setup

After the local server is running, go to http://localhost:8090/ or you can just go to the application http://localhost:8090/PaySystem

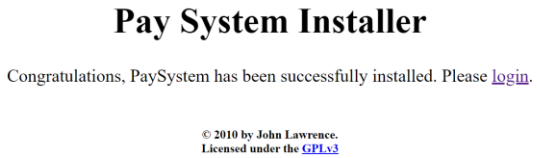
Enter the company name, and then click next.

Then you will be redirected to add information about the database.

To avoid confusion, database username and database password are kept same.

You will be redirected to add username and password for the user purpose. These are also kept same.

You will be redirected to the login page.



After clicking login, Login using the username you set earlier.

After login you will be directed to the dashboard. Below is the full dashboard.

Testing Team

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Musa Khan	MSCS-20065

References: List of documents, websites any other material to be referred.

We have cloned the source code in our repository. https://github.com/risaldar/PaySystem

All the reference material can be found in the repository.

2. List of Application Features to be tested

Following are the application features to be tested.

1. Wage can only be double (float) values.
2. Calculate hours worked for non-salaried and non-admin person.
3. Regular employee cannot log time for non-salaried person.
4. Approval of timesheet by timesheet approver.
5. Non-salaried person can log his own working time and send for approval.
6. A non-salaried and non-regular cannot approve his own time-sheet.
7. Only paid hour type shall appear in ADP report.
8. Employees added in ADP report shall have all combinations of employee properties. (Salaried, active, role, group).
9. Employees edit in ADP report shall have all combinations of employee properties.
10. Approved and Delete hours for employees by admin.
11. Date Hired cannot be greater than Full Time Date.

3. List of Testing Techniques Used

Following Black box testing techniques will be applied on the above mentioned use cases:

1. Equivalence Class
2. Boundary Value Analysis
3. Decision Table Testing
4. Domain Analysis
5. Pair-Wise Testing

4. Test Environment

Application execution environment

Operating system	Windows
Application servers	apache-tomcat-7.0.108-windows-x64 MySQL Server
Tools	Maven JDK1.8+ MySQL Workbench

5. Test Cases (Blackbox Testing)

Use Case # 1: Wage can only be double (float) values.

We shall use Equivalence class and boundary value analysis technique to test this feature. Since no description is provided to user on web page, it is assumed that valid input to this function shall be any non-negative real value. So we define two class in this case,

Equivalence Class Partitioning:

Class #	Class Type: Valid Class (VC) / Invalid Class (IC)	Description
C1	IC	All negative real numbers i.e. Wage < 0.0
C2	VC	All non-negative real numbers i.e. Wage >= 0.0

Boundary Value Analysis. (Assume smallest part to be 1/100 of fractional part)

Boundary #	Boundary Types: Valid Boundary (VB) / Invalid Boundary (IB)	Description	Class Reference
B1	IB	Wage = -0.01	C1

B2	VB	Wage = 0.00	C1
B3	VB	Wage = 0.01	C1
B4	IB	Wage = -0.01	C2
B5	VB	Wage = 0.00	C2
B6	VB	Wage = 0.01	C2

Test Scenario ID	Manage Account	**Test Case ID**	001
Test Case Objective	Test current user's wage entry functionality in account management.	**Test Priority**	High
Test browser	Chrome		
Pre-condition	Registered user should be logged in to the Pay system web portal and should be at his dashboard view page.	**Post-condition**	NA

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Go to 'Manage Account' section	N/A	http://localhost:8090/PaySystem/manageUser.jsp	http://localhost:8090/PaySystem/manageUser.jsp	Pass	N/A
2	Enter Wage and press Submit button	Wage: 0.0	Wage should be stored in database and user should go back to his dashboard http://localhost:8090/PaySystem/dashboard.jsp	Wage is stored in database and user can back to his dashboard http://localhost:8090/PaySystem/dashboard.jsp	Pass	N/A
3	Go to 'Manage Account' section	N/A	Wage should be same as previously stored in database	Wage is same as previously stored in database	Pass	N/A
Overall Result	☐ *Passed* ☐ *Failed* ☒ *Not Executed*					

Use Case # 2: Calculate hours worked for non-salaried and non-admin person.

We shall use Equivalence class and boundary value analysis technique to test this feature.

On the user page there is an option of PM check box, precondition is that the both boxes shall be unchecked for time started and for time ended.

Time ended and duration of lunch break shall have fixed values of 17:00 and 1:00 respectively.

Equivalence Class Partitioning:

Class #	Class Type: Valid Class (VC) / Invalid Class (IC)	Description
C1	VC	Time started between 0:00 – 24:00
C2	IC	Time started <= -1:00
C3	IC	Time started >= 25:00
C4	IC	When time started is a string

Boundary Value Analysis. (Assume smallest increment to be 1 hour)

Boundary #	Boundary Types: Valid Boundary (VB) / Invalid Boundary (IB)	Description	Class Reference
B1	VB	Time started = 0:00	C1
B2	VB	Time started = 24:00	C1
B3	IB	Time started = -1:00	C2
B4	IB	Time started = 25:00	C3

Test Scenario ID	Enter Time Started	**Test Case ID**	002
Test Case Objective	Test the hours calculation utility in time entry	**Test Priority**	High
Test browser	Chrome		
Pre-condition	Non – Salaried user should be logged in to the Pay system web portal and should be at his dashboard view page. http://localhost:8090/PaySystem/dashboard.jsp Go to 'Enter Time' section	**Post-condition**	NA

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Enter Time Started Time ended =17:00 Duration of Lunch =1:00 Click calculate	Time started: 12:00	The total hours in between those time started and time ended subtracted by lunch break duration shall appear in "Hours Worked" section on the same page.	The total hours in between those time started and time ended subtracted by lunch break duration are appeared in "Hours Worked" section on the same page.	Pass	N/A
Overall Result		☐ *Passed* ☐ *Failed* ☐ *Not Executed*				

Test Case Variations

Test Case #	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments (Class/Boundary reference)**
1	Time Started = 12:00 Time ended =17:00 Duration of Lunch =1:00	4	4	Pass	C1 (point within the class)
2	Time Started = -12:00 Time ended =17:00 Duration of Lunch =1:00	Error : Input is incorrect. Started time cannot be negative.	28	Fail	C2 (point within the class)
3	Time Started = 30:00 Time ended =17:00 Duration of Lunch =1:00	Error : Input is incorrect. Started time cannot be greater than 24:00.	-14	Fail	C3 (point within the class)
4	Time Started = "abc" Time ended =17:00	Error : Input is incorrect.	Error: Input is incorrect	Pass	C4 (point within the class)

	Duration of Lunch =1:00	Started time cannot be a string			
5	Time Started = 0:00 Time ended =17:00 Duration of Lunch =1:00	16	16	Pass	C1/B1 (point on the boundary) C2/B3 (point above the boundary)
6	Time Started = 1:00 Time ended =17:00 Duration of Lunch =1:00	15	15	Pass	C1/B1 (point above the boundary)
7	Time Started = -1:00 Time ended =17:00 Duration of Lunch =1:00	Error : Input is incorrect. Started time cannot be negative.	17	Fail	C1/B1 (point below the boundary) C2/B3 (point on the boundary)
8	Time Started = 24:00 Time ended =17:00 Duration of Lunch =1:00	Error : Input is incorrect. Started time cannot be greater than time ended.	-8	Fail	C1/B2 (point on the boundary) C3/B4 (point below the boundary)
9	Time Started = 25:00 Time ended =17:00 Duration of Lunch =1:00	Error : Input is incorrect. Started time cannot be greater than time ended.	-9	Fail	C1/B2 (point above the boundary) C3/B4 (point on the boundary)
10	Time Started = 23:00 Time ended =17:00 Duration of Lunch =1:00	Error : Input is incorrect. Started time cannot be greater than time ended.	-7	Fail	C1/B2 (point below the boundary)
11	Time Started = -2:00 Time ended =17:00 Duration of Lunch =1:00	Error : Input is incorrect. Started time cannot be negative.	18	Fail	C2/B3 (point below the boundary)
12	Time Started = 26:00 Time ended =17:00 Duration of Lunch =1:00	Error : Input is incorrect. Started time cannot be greater than time ended.	-10	Fail	C3/B4 (point above the boundary)

Use Case # 3: Regular employee cannot log time for other non-salaried person.

The requirements to be tested here are :

1. A regular employee cannot log time for other non-salaried person.
2. User with level of executive, manager, admin, asst manager and time approver can log time for themselves (if non-salaried) and other non-salaried person.

We shall use Decision Table for testing this function. We have used a systematic approach to identify the test cases.

Decision Table

		Rule-1	**Rule-2**	**Rule-3**	**Rule-4**	**Rule-5**	**Rule-6**
Condition #	**Input Conditions**						
C1	Signed in user is regular.	YES	YES	YES	NO	NO	NO
C2	Employee is non-salaried.	YES	YES	NO	YES	YES	NO
C3	Employee for which time is logged is other than current user.	YES	NO	YES	NO	YES	NO
Action #	**Output Actions**						
A1	Signed in user can access the manage time option and log time entry.	NO	NO	NO	YES	YES	NO

Test Scenario ID	Manage Time	**Test Case ID**	003
Test Case Objective	Test the time logging functionality for user with regular role while logging time for other users.	**Test Priority**	High
Test browser	Chrome		
Pre-condition	Registered user should be logged in to the Pay system web portal and should be at his dashboard view page. Go to "Manage Time" Section	**Post-condition**	NA

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Go to dashboard and find section 'Manage Time'	N/A	Section 'Manager Time' should not be available for regular role. It should be available for the roles of admin, executive, manager, asst. manager and time sheet approver.	Section 'Manage Time' is not available for regular role. It is available for admin, executive, manager, asst. manager and time sheet approver	Pass	N/A
2	Go to section 'Manage Time'	N/A	http://localhost:8090/PaySystem/manageTime.jsp	http://localhost:8090/PaySystem/manageTime.jsp	Pass	N/A
3	In the employee tab, select the employee	N/A	Only non-salaried employees should be visible in the drop down menu	Only non-salaried employees are visible in the drop down menu	Pass	N/A
4	Select date, hour types and hours for the employee	Date = 26/06/2021 Hour types = Regular Hours= 5	Hours logged should be visible inside the calendar against the date	Hours logged are visible inside the calendar against the date.	Pass	N/A
Overall Result	☐ *Passed* ☐ *Failed* ☐ *Not Executed*					

Test Case Variations

Test Case #	Inputs	Expected Output	Actual Output	Test Result	Test Comments (Decision Table Rule reference)
1	Sign in with user (non-salaried, regular role) and look for Manage time section to log time for other non-salaried employee.	System does not allow Manage Time logging for other user	System does not allow Manage Time logging for other user	Pass	Rule 1
2	Sign in with user (non-salaried, regular role) and look for Manage time section to log time for current user.	System does not allow Manage Time logging for other user	System does not allow Manage Time logging for other user	Pass	Rule 2
3	Sign in with user (salaried, regular role) and look for Manage time section to log time for current user.	System does not allow Manage Time logging for other user	System does not allow Manage Time logging for other user	Pass	Rule 3
4	Sign in with user (non-salaried, manager role) and look for Manage time section to log time for current user.	User can access the Manage time section and enter the time for himself	User can access the Manage time section and enter the time for himself	Pass	Rule 4
5	Sign in with user (non-salaried, asst. manager role) and look for Manage time section to log time for other non-salaried employee.	User can access the Manage time section and enter the time for himself	User can access the Manage time section and enter the time for himself	Pass	Rule 5
6	Sign in with user (salaried, executive role) and look for Manage time section to log time for current user.	Drop down menu in Manage time wont show the salaried employees.	Drop down menu in Manage time wont show the salaried employees.	Pass	Rule 6

Use Case # 4: Approval of timesheet by timesheet approver.

The requirements to be tested here are:

1. Only timesheet approver can approve the hours logged for any employee.
2. User cannot approve his own time.

We shall use Decision Table for testing this function. We have used a systematic approach to identify the test cases.

Decision Table

		Rule-1	**Rule-2**	**Rule-3**	**Rule-4**
Condition #	**Input Conditions**				
C1	Signed in user role is timesheet approver.	YES	YES	NO	NO
C2	Employee for which sheet is approved other than current user.	YES	NO	YES	NO
Action #	**Output Actions**				
A1	Signed in user can approve the logged hours.	YES	NO	NO	NO

Test Scenario ID	Manage Time	**Test Case ID**	004
Test Case Objective	Test the logged time entry approval functionality for user with role time sheet approver for time entries logged by other users who are non-salaried.	**Test Priority**	High
Test browser	Chrome		
Pre-condition	Registered user should be logged in to the Pay system web portal and should be at his dashboard view page.	**Post-condition**	NA

Step No	Action	Inputs	Expected Output	Actual Output	Test Result	Test Comments
1	Go to dashboard and find section 'Manage Time'	N/A	Section 'Manager Time' should not be available for regular role. It should be available for the roles of admin, executive, manager, asst. manager and time sheet approver.	Section 'Manage Time' is not available for regular role. It is available for admin, executive, manager, asst. manager and time sheet approver	Pass	N/A
2	Go to section 'Manage Time'	N/A	http://localhost:8090/PaySystem/manageTime.jsp	http://localhost:8090/PaySystem/manageTime.jsp	Pass	N/A
3	In the employee tab, select the employee	N/A	Only non-salaried employees should be visible in the drop down menu Hours logged should be visible inside the calendar against the date	Only non-salaried employees are visible in the drop down menu Hours logged are visible inside the calendar against the date.	Pass	N/A
4	In the calendar, Click approve button for the time logged.	Select employee for which time approval is needed.	Approve button shall disappear after the approval.	Approve button is disappeared after the approval.	Pass	N/A
Overall Result		☐ *Passed* ☐ *Failed* ☐ *Not Executed*				

Test Case Variations

Test Case #	Inputs	Expected Output	Actual Output	Test Result	Test Comments (Decision Table Rule reference)
1	Sign in with user (time-sheet approver role) and look for Manage time section to approve logged time for other non-salaried employee.	Approve button will appear in calendar which shows System allows user to approve time.	Approve button is appeared in calendar which shows system allowed user to approve time.	Pass	Rule 1
2	Sign in with user (time-sheet approver role) and look for Manage time section to approve logged time for current user.	Approve button will not appear in calendar which shows System does not allow user to approve time for himself.	Approve button is not appeared in calendar which shows System does not allow user to approve time for himself.	Pass	Rule 2
3	Sign in with user (executive role) and look for Manage time section to approve logged time for other non-salaried employee.	Approve button will not appear in calendar because only time-sheet approver can approve time sheet.	Approve button is appeared in calendar.	Fail	Rule 3
4	Sign in with user (manager role) and look for Manage time section approve logged time for current user.	Approve button will not appear in calendar which shows System does not allow user to approve time for himself.	Approve button will not appear in calendar which shows System does not allow user to approve time for himself.	Pass	Rule 4

Use Case # 5: Non-salaried person can log his own working time and send for approval.

We shall use Decision Table for testing this function. It is not a complex condition but systematic approach to identification of test cases is still applicable.

Decision Table

		Rule-1	Rule-2
Condition #	**Input Conditions**		
C1	user is non-salaried	YES	NO
Action #	**Output Actions**		
A1	User can log time entry	YES	NO
A2	User entry shall be accessible for approval to time sheet approver	YES	NO

Test Scenario ID	Enter Time	**Test Case ID**	005
Test Case Objective	Test the personal time entry functionality for non-salaried user.	**Test Priority**	High
Test browser	Chrome		
Pre-condition	Registered user should be logged in to the Pay system web portal and should be at his dashboard view page.	**Post-condition**	NA

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Go to dashboard and find section 'Enter Time'	N/A	Section 'Enter Time' is available on user dashboard	Section 'Enter Time' is available on user dashboard	Pass	N/A
2	Go to section 'Enter Time'	N/A	http://localhost:8090/PaySystem/timeEntering.jsp	http://localhost:8090/PaySystem/timeEntering.jsp	Pass	N/A
3	Select Date, Type and enter Hours worked.	Date: Current Date Type: Office Hours Hours Worked: 8	A pop-up comes up saying 'Successfully submitted the	A pop-up comes up saying 'Successfully submitted the	Pass	N/A

	Press 'Submit Hours' button.		hours.'	hours.'		
4	Press 'OK' on pop-up	N/A	User is taken back to Enter time section.	User is taken back to Enter time section.	Pass	N/A
5	Press 'Logout'	N/A	http://localhost:8090/PaySystem/logout.jsp	http://localhost:8090/PaySystem/logout.jsp	Pass	N/A
6	Login as employee with rights to approve the filled in time entry.	User Name: admin Password: admin	http://localhost:8090/PaySystem/index.jsp	http://localhost:8090/PaySystem/index.jsp	Pass	N/A
7	Go to Manage Time section	N/A	http://localhost:8090/PaySystem/manageTime.jsp	http://localhost:8090/PaySystem/manageTime.jsp	Pass	N/A
8	Select 'Employee' as previously logged in user and approve his time entry	Employee: developer_1	http://localhost:8090/PaySystem/manageTime.jsp	http://localhost:8090/PaySystem/manageTime.jsp	Pass	N/A
Overall Result	☐ *Passed* ☐ *Failed* ☒ *Not Executed*					

Use Case # 6: A non-salaried and non-regular cannot approve his own time-sheet.

We shall use Decision Table for testing this function. It is not a complex condition but systematic approach to identification of test cases is still applicable. In current use case, we shall only consider Role of 'Time Sheet Approver' as non-'Regular'.

Decision Table

		Rule-1	**Rule-2**	**Rule-3**	**Rule-4**
Condition #	**Input Conditions**				
C1	user role == 'Time Sheet Approver'	YES	YES	NO	NO

C2	user is non-salaried	YES	NO	YES	NO
Action #	**Output Actions**				
A1	User can log time entry	YES	NO	NO	NO
A2	User entry shall be accessible for approval to time sheet approver	NO	NO	NO	NO

Test Scenario ID	Enter Time / Manage Time	**Test Case ID**	006
Test Case Objective	Test the time entry approval functionality against self-approval for non-salaried and non-regular employees.	**Test Priority**	High
Test browser	Chrome		
Pre-condition	Registered user should be logged in to the Pay system web portal and should be at his dashboard view page.	**Post-condition**	NA

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Go to dashboard and find section 'Enter Time'	N/A	Section 'Enter Time' is available on user dashboard	Section 'Enter Time' is available on user dashboard	Pass	N/A
2	Go to section 'Enter Time'	N/A	http://localhost:8090/PaySystem/timeEntering.jsp	http://localhost:8090/PaySystem/timeEntering.jsp	Pass	N/A
3	Select Date, Type and enter Hours worked. Press 'Submit Hours' button.	Date: Current Date Type: Office Hours Hours Worked: 8	A pop-up comes up saying 'Successfully submitted the hours.'	A pop-up comes up saying 'Successfully submitted the hours.'	Pass	N/A
4	Press 'OK' on pop-up	N/A	User is taken back to Enter time section.	User is taken back to Enter time section.	Pass	N/A
5	Press 'Dashboard'	N/A	http://localhost:8090/PaySystem/dashboard.jsp	http://localhost:8090/PaySystem/dashboard.jsp	Pass	N/A

7	Go to Manage Time section	N/A	http://localhost:8090/PaySystem/manageTime.jsp	http://localhost:8090/PaySystem/manageTime.jsp		
8	Select 'Employee' as self and approve time entry	Employee: time_sheet_approver_1	'Employee' drop down menu shall not have option to select current user.	'Employee' drop down menu shall not have option to select current user.	Pass	N/A
Overall Result	☐ *Passed* ☐ *Failed* ☒ *Not Executed*					

Use Case # 7: Only paid hour type shall appear in ADP report.

We shall apply Pair-Wise Testing technique here since the aim is to verify that all combinations of paid/unpaid hours with active/inactive employees having salaried/non-salaried type.

Variable Names	Hour Type	Salaried Type	Active type
Values (Choices) Count	2	2	2

Select Orthogonal Array: $\mathbf{L_4\,(2^3)}$ since we have 3 variables which can be covered by array of 3 variables having 2 options each.

Map the Problem to Orthogonal Array:

Variable Names ->	**Hour Type**	**Salaried type**	**Active type**
	[0] Paid	[0] salaried	[0] active
	[1] Unpaid	[1] Non-salaried	[1] inactive

Orthogonal Array:

Hour Type	**Salaried Type**	**Active type**
Paid	Salaried	Active

Paid	Non-salaried	Inactive
Unpaid	Salaried	Inactive
Unpaid	Non-salaried	Active

Test Scenario ID	Report	**Test Case ID**	007
Test Case Objective	Test the ADP report functionality which should only include logged time entries which include paid hours for non-salaried active employees.	**Test Priority**	High
Test browser	Chrome		
Pre-condition	Registered user (with admin or executive role) should be logged in to the Pay system web portal and should be at his dashboard view page. All hours type against different employees should have been logged and should be already created in pay system database.	**Post-condition**	NA

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Go to 'Reports' section	N/A	http://localhost:8090/PaySystem/reports.jsp	http://localhost:8090/PaySystem/reports.jsp	Pass	N/A
2	Enter Batch ID and description, click next	Batch ID: 1 Batch Description: Test Report	http://localhost:8090/PaySystem/reports.jsp	http://localhost:8090/PaySystem/reports.jsp	Pass	N/A
3	Click Finalize Data	N/A	'adpImport.csv' file should be downloaded which lists all registered employees.	adpImport.csv downloaded.	Pass	N/A
Overall Result	☐ *Passed* ☐ *Failed* ☐ *Not Executed*					

Test Case Variations

Test Case #	Inputs	Expected Output	Actual Output	Test Result	Test Comments (Orthognal Array Row reference)
1	Log 5 paid hours for active, salaried employee. Go to Report Section to view report.	5 hours should not be logged and should not appear in adp Report because employee is salaried.	5 hours could not be logged and are not appeared in adp Report because employee is salaried.	Pass	Row 1
2	Log 5 paid hours for inactive, non-salaried employee. Go to Report Section to view report.	5 hours should not appear in adp Report because employee is inactive.	5 hours are not appeared in adp Report because employee is inactive.	Pass	Row 2
3	Log 5 unpaid hours for inactive, salaried employee. Go to Report Section to view report.	5 hours should not appear in adp Report because employee is inactive and hours are unpaid.	5 hours should not appear in adp Report because employee is inactive and hours are unpaid.	Pass	Row 3
4	Log 5 unpaid hours for active, non-salaried employee. Unpaid, Salaried, Active	5 hours should not appear in adp Report because employee is salaried and hours are unpaid.	5 hours should not appear in adp Report because employee is salaried and hours are unpaid.	Pass	Row 4

Here, the orthogonal array could not give us the combination in which we can see log hours. That combination is paid, Non-salaried, active.

Use Case # 8: Employs added in ADP report shall have all combinations of employee properties.

We shall apply Pair-Wise Testing technique here since the aim is to verify that all combinations of employee properties are included in ADP report. For sake of simplicity, we can only consider following 4 variables in employee attributes. Some combinations of attributes are not logical but are kept in place for sake of testing e.g. Employee with 'Administrator' role should not belong to any group other than 'admin'.

Variable Names	Group	Role	Active	Salaried
Values (Choices) Count	3	6	2	2

Select Orthogonal Array: $\mathbf{L_{18}(3_6 6_1)}$ since we have 3 variables which can be covered by array variables of 3 options and 1 variable with 6 options.

Map the Problem to Orthogonal Array:

Variable Names	**Choices**					
Group	[0] admin	[1] developer	[2] management			
Role	[0] Administrator	[1] Executive	[2] Manager	[3] Assistant Manager	[4] Time Sheet Approver	[5] Regular Employee
Active	[0] active	[1] inactive	[2] active (repeated)			
Salaried	[0] salaried	[1] non-salaried	[2] salaried (repeated)			

Test Inputs:

Group	**Salaried**	**Active**	**Role**
Admin	Salaried	active	Administrator
developer	Salaried	active	Executive
management	Salaried	inactive	Manager
admin	non-salaried	active	Assistant Manager
management	non-salaried	active	Time Sheet Approver
developer	Salaried	inactive	Regular Employee
management	non-salaried	active	Regular Employee
admin	Salaried	inactive	Time Sheet Approver
developer	non-salaried	inactive	Administrator
management	Salaried	active	Executive
developer	Salaried	active	Assistant Manager
admin	Salaried	active	Manager
management	Salaried	inactive	Assistant Manager
developer	non-salaried	active	Manager
developer	Salaried	active	Time Sheet Approver
admin	Salaried	active	Regular Employee
admin	non-salaried	inactive	Executive

management	Salaried	active	Administrator

Test Scenario ID	Enter	**Test Case ID**	008
Test Case Objective	Employs added in ADP report shall have all combinations of employee properties. (Salaried, active, role, group).	**Test Priority**	High
Test browser	Chrome		
Pre-condition	All employees with properties in table of test input given above should be already created in pay system database. Registered user should be logged in to the Pay system web portal and should be at his dashboard view page.	**Post-condition**	NA

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Go to 'Reports' section	N/A	http://localhost:8090/PaySystem/reports.jsp	http://localhost:8090/PaySystem/reports.jsp	Pass	N/A
2	Enter Batch ID and description, click next	Batch ID: 1 Batch Description: Test Report	http://localhost:8090/PaySystem/reports.jsp	http://localhost:8090/PaySystem/reports.jsp	Pass	N/A
3	Click Finalize Data	N/A	'adpImport.csv' file should be downloaded which lists all registered employees.	'adpImport.csv' file is downloaded which lists all registered employees.	Pass	N/A
Overall Result	☐ *Passed* ☐ *Failed* ☒ *Not Executed*					

Use Case # 9: Employees edit in ADP report shall have all combinations of employee properties.

Test Scenario ID	Admin	**Test Case ID**	009
Test Case Objective	Test the edit functionality of user that is added by admin in system	**Test Priority**	High
Pre-condition	admin should be logged in to the Pay system web portal and should be at his dashboard view page.	**Post-condition**	N/A

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comment**
1	Launch the application	localhost:8090/PaySystem	Application login page	Application login page	Pass	N/A
2	Go to dashboard and find section 'Manage Employees'	N/A	http://localhost:8090/PaySystem/manageEmployees.jsp	http://localhost:8090/PaySystem/manageEmployees.jsp	Pass	N/A
3	Click on Add	N/A	http://localhost:8090/PaySystem/editEmployee.jsp	http://localhost:8090/PaySystem/editEmployee.jsp	Pass	N/A
4	Enter data in every input field except Name	Name: null Date Hired: '2021-06-03' Full Time Date:	http://localhost:8090/PaySystem/manageEmployees.jsp	http://localhost:8090/PaySystem/manageEmployees.jsp	Pass	N/A

		'2021-06-03' Group: other Role: 'Regular Employee' User Name: 'test' Password: 'abcd1234' Verify Password: 'abcd1234' Email Address: test@gnail.com File Number: 1499				
5	Now click on the edit section of added user	N/A	Should open the edit form	Page Crash	Failed	N/A
Overall Result		☐*Failed*				

Use Case # 10: Approved and Delete hours for employees by admin:

Test Scenario ID	Admin	**Test Case ID**	010

Test Case Objective	Admin added hours to other users are already approved but he can approve user added hours.	**Test Priority**	High
Pre-condition	admin should be logged in to the Pay system web portal and should be at his dashboard view page.	**Post-condition**	N/A

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comment**
1	Launch the application	localhost:8090/PaySystem	Application login page	Application login page	Pass	N/A
2	Go to dashboard and find section 'Manage Time'	N/A	http://localhost:8090/PaySystem/manageTime.jsp	http://localhost:8090/PaySystem/manageEmployees.jsp	Pass	N/A
3	Now admin can select user from employee dropdown	Select employee name	Employee data in calendar	Employee data in calendar	Pass	N/A
4	Now admin can approve and delete hours that	After clicking on approved	http://localhost:8090/PaySystem/manageTime.jsp	http://localhost:8090/PaySystem/manageTime.jsp	Pass	N/A

	added by admin					
Overall Result	☐*Passed*					

Use Case # 11: Date Hired cannot be greater than Full Time Date:

Equivalence Class Partitioning:

Class #	Class Type: Valid Class (VC) / Invalid Class (IC)	Description
C1	IC	Date Hired > Full Time Date
C2	VC	Date Hired < Full Time Date

Boundary Value Analysis.(Assume Date Hired is: 2021-06-16)

Boundary #	Boundary Types: Valid Boundary (VB) / Invalid Boundary (IB)	Description	Class Reference
B1	VB	Full Time Date = 2021-06-17	C2
B2	VB	Full Time Date = 2021-06-16	C2
B3	IB	Full Time Date = 2021-06-14	C1

Test Scenario ID	Admin Account	**Test Case ID**	011
Test Case Objective	Date hired of employee should be less than full time date	**Test Priority**	High

Test browser	Chrome		
Pre-condition	Registered Admin should be logged in to the Pay system web portal and should be at his dashboard view page.	**Post-condition**	NA

Step No	**Action**	**Inputs**	**Expected Output**	**Actual Output**	**Test Result**	**Test Comments**
1	Go to 'Manage Employees' section	N/A	http://localhost:8090/PaySystem/manageEmployees.jsp	http://localhost:8090/PaySystem/manageEmployees.jsp	Pass	N/A
2	Admin can click on add and edit any user	N/A	http://localhost:8090/PaySystem/manageEmployee.jsp?id=8	http://localhost:8090/PaySystem/manageEmployee.jsp?id=8	Pass	N/A
3	Admin can start entering data with invalid dates	Name: Stewart Date Hired: '2021-06-03' Full Time Date: '2021-06-02' Group: other Role: 'Regular Employee' User Name: 'test'	Internal Server error	Internal Server error	Pass	Date hired of employee is less than full time date

		Password: 'abcd1234' Verify Password: 'abcd1234' Email Address: test@gnail.com File Number: 1499				
4	Admin can start entering data with valid dates	Name: Stewart Date Hired: '2021-06-03' Full Time Date: '2021-06-04' Group: other Role: 'Regular Employee' User Name: 'test' Password: 'abcd1234' Verify Password: 'abcd1234' Email Address: test@gnail.com	http://localhost:8090/PaySystem/manageEmployees.jsp	http://localhost:8090/PaySystem/manageEmployees.jsp	Pass	Date hired of employee is greater than full time date

		File Number: 1499				
Overall Result	☐*Passed*					

6. Test Cases (Whitebox Testing)

Function 1:

Encodes a byte array into Base64 format.

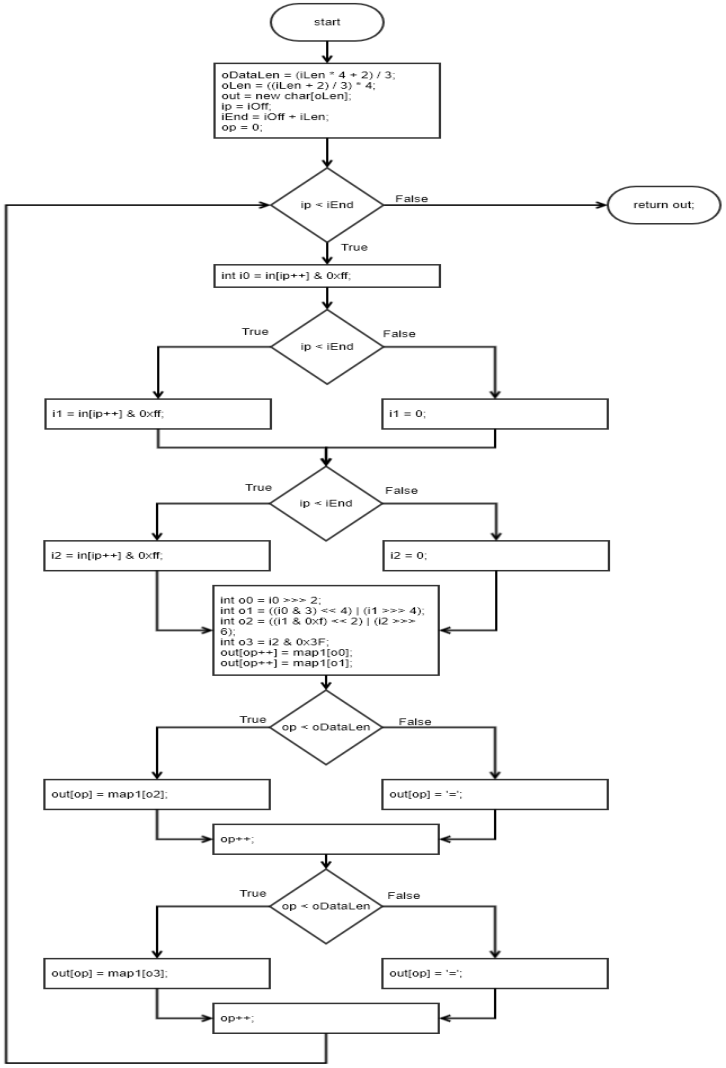
Note: map[] table is populated in another constructor function.

Source Code:

timesheet-master\src\main\java\timeSheet\util\properties\Base64Coder.java

```java
public char[] encode(byte[] in, int iOff, int iLen) {
    int oDataLen = (iLen * 4 + 2) / 3;       // output length without padding
    int oLen = ((iLen + 2) / 3) * 4;         // output length including padding
    char[] out = new char[oLen];
    int ip = iOff;
    int iEnd = iOff + iLen;
    int op = 0;
    while (ip < iEnd) {
        int i0 = in[ip++] & 0xff;
        int i1 = ip < iEnd ? in[ip++] & 0xff : 0;
        int i2 = ip < iEnd ? in[ip++] & 0xff : 0;
        int o0 = i0 >>> 2;
        int o1 = ((i0 & 3) << 4) | (i1 >>> 4);
        int o2 = ((i1 & 0xf) << 2) | (i2 >>> 6);
        int o3 = i2 & 0x3F;
        out[op++] = map1[o0];
        out[op++] = map1[o1];
        out[op] = op < oDataLen ? map1[o2] : '=';
        op++;
        out[op] = op < oDataLen ? map1[o3] : '=';
        op++;
    }
    return out;
}
```

CFG:



Statement Coverage:

Test case#	Input	Expected Output	Comments/Remarks

1	In[] = {'A', 'B', 'C'};
	iOff = 0;
	iLen = 3;
		QUJD	Covers all statements

Branch Coverage:

Test case#	Input	Expected Output	Comments/Remarks

1	In[] = {'A', 'B', 'C'};
	iOff = 0;
	iLen = 3;
		QUJD	Covers 66TF, 68T, 69T, 76T, 78T

2	In[] = {'A', 'B', 'C'};
	iOff = 0;
	iLen = 1;
		QQ==	Covers 66TF, 68F, 69F, 76F, 78F

Condition Coverage with Short Circuit Evaluation:

Test case#	Input	Expected Output	Comments/Remarks

1	In[] = {'A', 'B', 'C'};
	iOff = 0;
	iLen = 3;
		QUJD	Covers 66TF, 68T, 69T, 76T, 78T

2	In[] = {'A', 'B', 'C'};
	iOff = 0;
	iLen = 1;
		QQ==	Covers 66TF, 68F, 69F, 76F, 78F

Boundary Interior:

Possible logical paths

- Path A: 68T, 69T, 76T, 78T
- Path B: 68T, 69F, 76T, 78F
- Path C: 68F, 69F, 76F, 78F

Test case#	Input	Expected Output	Comments/Remarks
1	In[] = {'A', 'B', 'C'};	QUJD	Covers Path A

	iOff = 0;
	
	iLen = 3;		

2	In[] = {'A', 'B', 'C'};
	
	iOff = 0;
	
	iLen = 1;
		QQ==	Covers Path B

3	In[] = {'A', 'B', 'C'};
	
	iOff = 0;
	
	iLen = 2;
		QUI=	Covers Path C

Loop Boundary:

Consider N for loop boundary as 5

Test case#	Input	Expected Output	Comments/Remarks
1	In[] = {'A', 'B', 'C'}; iOff = 0;	Empty string	Covers 66F

	iLen = 0;		

2	In[] = {‘A’, ‘B’, ‘C’};
	
	iOff = 0;
	
	iLen = 3;
		QUJD	Covers 66T once

3	In[] = {‘A’, ‘B’, ‘C’, ‘D’};
	
	iOff = 0;
	
	iLen = 4;
		QUJDRA==	Covers 66T at N-1

4	In[] = {‘A’, ‘B’, ‘C’, ‘D’, ‘E’};
	
	iOff = 0;
	
	iLen = 5;
		QUJDREU=	Covers 66T at N

54	In[] = {‘A’, ‘B’, ‘C’, ‘D’, ‘E’, ‘F’};
	
	iOff = 0;
	
	iLen = 6;
		QUJDREVG	Covers 66T at N+1

Basis Path:

Edges - Nodes + 2 = 22 – 18 + 2 = 6

Path 1: 66F

Path 2: 66T, 68T, 69T, 76T, 78T

Path 3: 66T, 68T, 69F, 76T, 78F

Path 4: 66T, 68F, 69F, 76F, 78F

Path 5: 66T, 68F, 69F, 76F, 78T

Path 6: 66T, 68F, 69T, 76F, 78F

Note that no logical path is possible to cause 69T while 68F. Same is the case with 76F and 78T. Similarly, conditions in 76 and 78 also depend upon the same factor as 68, 69 so it is not possible for 68T but 76F and vice versa.

Test case#	**Input**	**Expected Output**	**Comments/Remarks**

1	In[] = {'A', 'B', 'C'};
	iOff = 0;
	iLen = 3;
		QUJD	Covers Path2

2	In[] = {'A', 'B', 'C'};
	
	iOff = 0;
	
	iLen = 1;
		QQ==	Covers Path4

3	In[] = {'A', 'B', 'C'};
	
	iOff = 0;
	
	iLen = 0;
		Empty String	Covers Path1

4	In[] = {'A', 'B', 'C'};
	
	iOff = 0;
	
	iLen = 2;
		QUI=	Covers Path3

Data Flow Testing:

Variable #	Variable Name	Definitions	Uses
1	iLen	59	60, 61, 64
2	oLen	61	62
3	Op	65, 74, 75, 77, 79	74, 75, 76, 77, 78, 79

Variable #	Variable Name	DU pairs
1	iLen	<59, 60>, <59, 61>, <59, 64>
2	oLen	<61, 62>
3	Op	<65,74>, <74,75>, <75,76>, <75,77>, <77,78>, <77,79>, <79,74>

Test case#	Input	Expected Output	Comments/Remarks

1	In[] = {'A', 'B', 'C', 'D', 'E', 'F'};
	
	iOff = 0;
	
	iLen = 6;
		QUJDREVG	iLen = Covers <59, 60>, <59, 61>, <59, 64>
			
			oLen = Covers <61, 62>
			
			op = Covers <65,74>, <74,75>, <75,76>, <75,77>, <77,78>, <77,79>, <79,74>

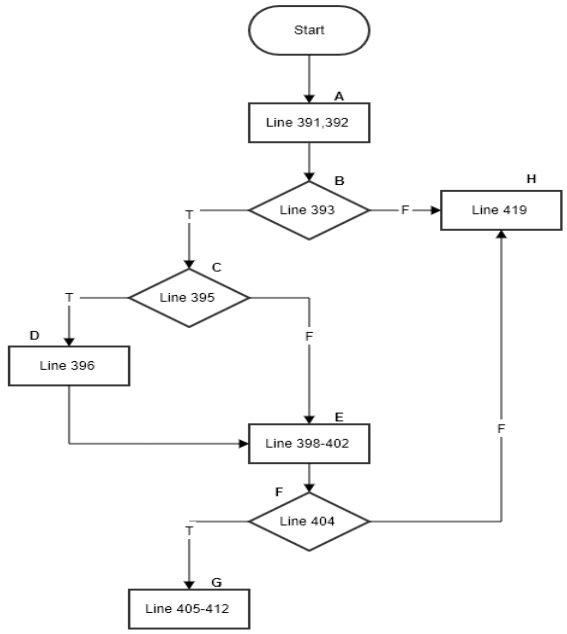
Function 2:

Source Code:

https://github.com/openjdk/jdk/tree/master/src/java.base/share/classes/java/time/Duration.java

```
390     public static Duration parse(CharSequence text) {
391         Objects.requireNonNull(text, "text");
392         Matcher matcher = Lazy.PATTERN.matcher(text);
393         if (matcher.matches()) {
394             // check for letter T but no time sections
395             if (!charMatch(text, matcher.start(3), matcher.end(3), 'T')) {
396                 boolean negate = charMatch(text, matcher.start(1), matcher.end(1), '-');
397 
398                 int dayStart = matcher.start(2), dayEnd = matcher.end(2);
399                 int hourStart = matcher.start(4), hourEnd = matcher.end(4);
400                 int minuteStart = matcher.start(5), minuteEnd = matcher.end(5);
401                 int secondStart = matcher.start(6), secondEnd = matcher.end(6);
402                 int fractionStart = matcher.start(7), fractionEnd = matcher.end(7);
403 
404                 if (dayStart >= 0 || hourStart >= 0 || minuteStart >= 0 || secondStart >= 0) {
405                     long daysAsSecs = parseNumber(text, dayStart, dayEnd, SECONDS_PER_DAY, "days");
406                     long hoursAsSecs = parseNumber(text, hourStart, hourEnd, SECONDS_PER_HOUR, "hours");
407                     long minsAsSecs = parseNumber(text, minuteStart, minuteEnd, SECONDS_PER_MINUTE, "minutes");
408                     long seconds = parseNumber(text, secondStart, secondEnd, 1, "seconds");
409                     boolean negativeSecs = secondStart >= 0 && text.charAt(secondStart) == '-';
410                     int nanos = parseFraction(text, fractionStart, fractionEnd, negativeSecs ? -1 : 1);
411                     try {
412                         return create(negate, daysAsSecs, hoursAsSecs, minsAsSecs, seconds, nanos);
413                     } catch (ArithmeticException ex) {
414                         throw (DateTimeParseException) new DateTimeParseException("Text cannot be parsed to a Duration: overflow", text, 0).initCause(ex);
415                     }
416                 }
417             }
418         }
419         throw new DateTimeParseException("Text cannot be parsed to a Duration", text, 0);
420     }
```

CFG:



Statement Coverage:

Line 414 exception case is not covered under sir's guidance.

Test case#	Input	Expected Output	Comments/Remarks
1	text = "PT6H"	"6 hours"	Covers statements from 391 to 395, 398 to 412
2	text = "G3D"	"Exception"	Covers statement 419

3	text = “-P2D”	“-2 days”	Covers statement 396

Branch Coverage:

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	text = “PT6H”	“6 hours”	Covers B393T, B395F, B404T
2	text = “G3D”	Exception	Covers B393F
3	text= “-PT6H3M”	“-6 Hours and -3 minutes”	Covers B393T, B395T
4	text= “PTDHM”	Exception	Covers B404F

Condition Coverage with Short Circuit Evaluation:

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	text = “PT6H”	“6 hours”	Covers C393T, C395F, C404-1T

2	text = “G3D”	Exception	Covers C393F
3	text= “PT-6D6H”	“-6 Days and 6 Hours”	Covers C393T, C395T, C404-1F, C404-2T
4	text= “PT-6D-6H6M”	“-6 Days and -6 Hours and 6 minutes”	Covers C393T, C395T, C404-1F, C404-2F, C404-3T
5	text= “PT-6D-6H-6M6S”	“-6 Days and -6 Hours and -6 minutes and 6 seconds”	Covers C393T, C395T, C404-1F, C404-2F, C404-3F, C404-4T
6	text= “PT-6D-6H-6M-6S”	Exception	Covers C393T, C395T, C404-1F, C404-2F, C404-3F, C404-4F

Boundary Interior:

Boundary Interior Technique cannot be applied to this function because it does not contain any loop.

Loop Boundary:

Loop Boundary Technique cannot be applied to this function because it does not contain any loop.

Basis Path:

No. of Basis Paths = No. of decision points + 1

No. of Basis Paths = 3 + 1 = 4

Path 1: ABCDEFG

Path 2: ABH

Path 3: ABCEFG

Path 4: ABCEFH

Test case#	Input	Expected Output	Comments/Remarks
1	text = “PT-6H3M”	“6 Hours and -3 minutes”	Covers path ABCDEFG
2	text = “G3D”	“Exception”	Covers path ABH
3	text = “PT6H”	“6 hours”	Covers ABCEFG

4	text= “PTDHM”	Exception	Covers ABCEFH

Data Flow Testing:

Variable #	Variable Name	Definitions	Uses
1	matcher	392	393, 395, 396, 398, 399, 400, 401, 402
2	dayStart	398	404, 405
3	hourStart	399	404, 406

Variable #	Variable Name	DU pairs
1	Matcher	<392, 393> <392, 395> <392, 396> <392, 398> <392, 399> <392, 400> <392, 401> <392, 402>

2	dayStart	<398, 404> <398,405>
3	hourStart	<399, 404> <399,406>

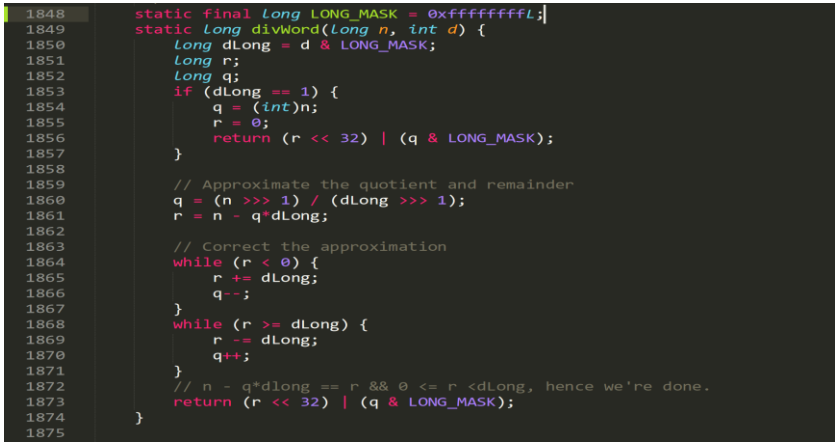
Test case#	Input	Expected Output	Comments/Remarks
1	text ="-PT2D6H4M20.345S"	"-2 days and -6 Hours and -4 minutes and -20.345 seconds"	For matcher : Covers <392, 393> <392, 395> <392, 396> <392, 398> <392, 399> <392, 400> <392, 401> <392, 402> For dayStart: Covers <398, 404> <398, 405>

			For hourStar: Covers <398, 404> <398, 406>

Function 3:

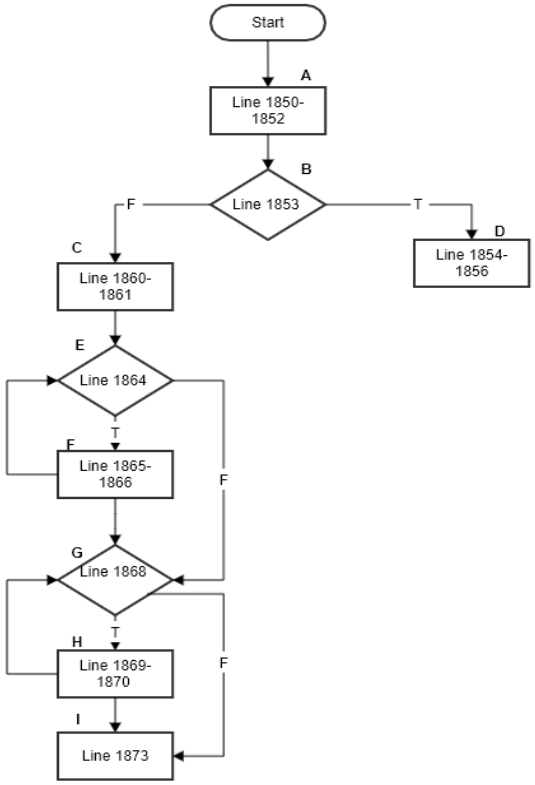
Source Code:

https://github.com/openjdk/jdk/tree/master/src/java.base/share/classes/java/math/ MutableBigInteger.java



```
1848    static final long LONG_MASK = 0xffffffffL;
1849    static long divWord(long n, int d) {
1850        long dLong = d & LONG_MASK;
1851        long r;
1852        long q;
1853        if (dLong == 1) {
1854            q = (int)n;
1855            r = 0;
1856            return (r << 32) | (q & LONG_MASK);
1857        }
1858
1859        // Approximate the quotient and remainder
1860        q = (n >>> 1) / (dLong >>> 1);
1861        r = n - q*dLong;
1862
1863        // Correct the approximation
1864        while (r < 0) {
1865            r += dLong;
1866            q--;
1867        }
1868        while (r >= dLong) {
1869            r -= dLong;
1870            q++;
1871        }
1872        // n - q*dlong == r && 0 <= r <dLong, hence we're done.
1873        return (r << 32) | (q & LONG_MASK);
1874    }
1875
```

CFG:



Statement Coverage:

Test case#	Input	Expected Output	Comments/Remarks
1	n = 16 d = 1	16	Covers Statement 1850-1857
2	n = 10 d = 3	4294967299	Covers Statement 1850,1851,1852, 1860-1868, 1873
3	-	-	Statement 1869- 1870 I think this is a dead code, I could not find any such case in which the condition at 1868 becomes True

Branch Coverage:

Test case#	Input	Expected Output	Comments/Remarks
1	n = 16 d = 1	16	Covers B1853T

2	n = 10 d = 3	4294967299	Covers B1853F , B1864TF, B1864F
3	-	-	Statement 1869- 1870 I think this is a dead code, I could not find any such case in which the condition at 1868 becomes True

Condition Coverage with Short Circuit Evaluation:

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	n = 16 d = 1	16	Covers C1853T
2	n = 10 d = 3	4294967299	Covers C1853F , C1864TF, C1864F

3	-	-	Statement 1869- 1870 I think this is a dead code, I could not find any such case in which the condition at 1868 becomes True

Boundary Interior:

Test case#	Input	Expected Output	Comments/Remarks
1	n = 10 d = 3	4294967299	Covers loop starting at Line 1864. This while loop has only one path.
2	-	-	Statement 1869- 1870 I think this is a dead code, I could not find any such case in which the condition at 1868 becomes True.

Loop Boundary:

I think Loop at line 1868 is a dead code, I could not find any such case in which the condition at 1868 becomes True.

Test cases are only for the loop at line 1864.

I choose loop upper bound = 5

Test case#	Input	Expected Output	Comments/Remarks
1	n =10 d = 5	2	Loop at line 1864 is skipped entirely.
2	n =5 d = 3	8589934593	Loop at line 1864 is run only once
3	n = 14 d = 6	8589934596	Loop at line 1864 is run 3 times.
4	n =20 d =3	8589934598	Loop at line 1864 is run 4 times
5	n = 28 d = 3	4294967305	Loop at line 1864 is run 5 times.

6	n = 32 d = 3	8589934602	Loop at line 1864 is run 6 times.

Basis Path:

No. of Basis Paths = No. of decision points + 1

No. of Basis Paths = 3 + 1 = 4

Path 1: ABD

Path 2: ABCEFGHI

Path 3: ABCEFGI

Path 4: ABCEGI

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	n = 16 d = 1	16	Covers path ABD
2	-	-	Path ABCEFGHI cannot be covered since the condition in the G block is

			never True so H block cannot be executed.
3	n =5 d = 3	8589934593	Covers path ABCEFGI
4	n = 10 d = 2	5	Covers path ABCEGI

Data Flow Testing:

Variable #	Variable Name	Definitions	Uses
1	dLong	1850	1853, 1860, 1861, 1865, 1868, 1869
2	N	1849	1854, 1860, 1861
3	q	1854, 1860, 1866, 1870	1856, 1861, 1866, 1870, 1873

Variable #	Variable Name	DU pairs
1	dLong	<1850,1853> <1850,1860> <1850,1861> <1850,1865>

		<1850,1868> <1850,1869>
2	n	<1849,1854> <1849,1860> <1850,1861>
3	q	<1854, 1856> <1860, 1861> <1860, 1866> <1860, 1870> <1860, 1873> <1866, 1866> <1866, 1870> <1866, 1873> <1870, 1870> <1870, 1873>

Test case#	Input	Expected Output	Comments/Remarks
1	n = 28 d = 3	4294967305	For dLong covers: <1850,1853> <1850,1860> <1850,1861> <1850,1865> <1850,1868>

			For n covers: <1849,1860> <1850,1861> For q covers: <1860, 1861> <1860,1866> <1866, 1866> <1866, 1873>
2	n = 10 d = 1	10	For dLong covers: <1850,1853> For n covers: <1849,1854> For q covers: <1854,1856>
3	n = 10	5	For dLong covers:

	d = 2		<1850,1853> <1850,1860> <1850,1861> For n covers: <1849,1860> <1849,1861> For q covers: <1860, 1873>
-	-	-	For q these DU pairs cannot be covered: <1870, 1870> <1870, 1873> <1866, 1870> <1866, 1873>

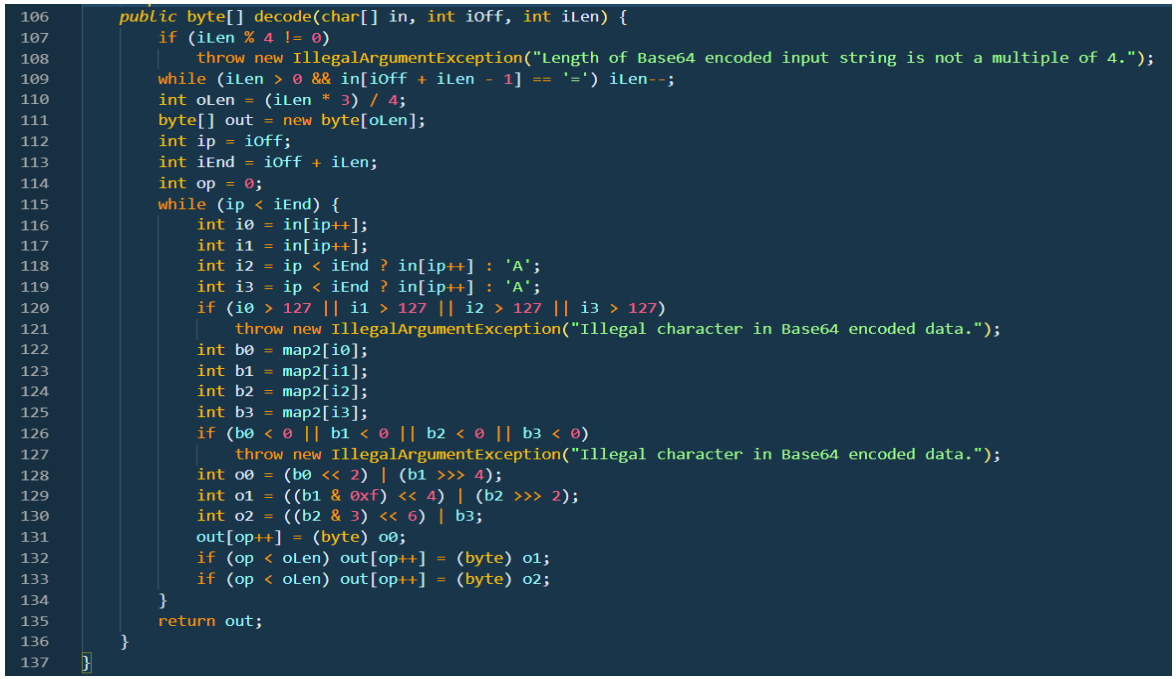
Function 4:

Decodes a byte array from Base64 format.

Note: map2[] table is populated in another constructor function.

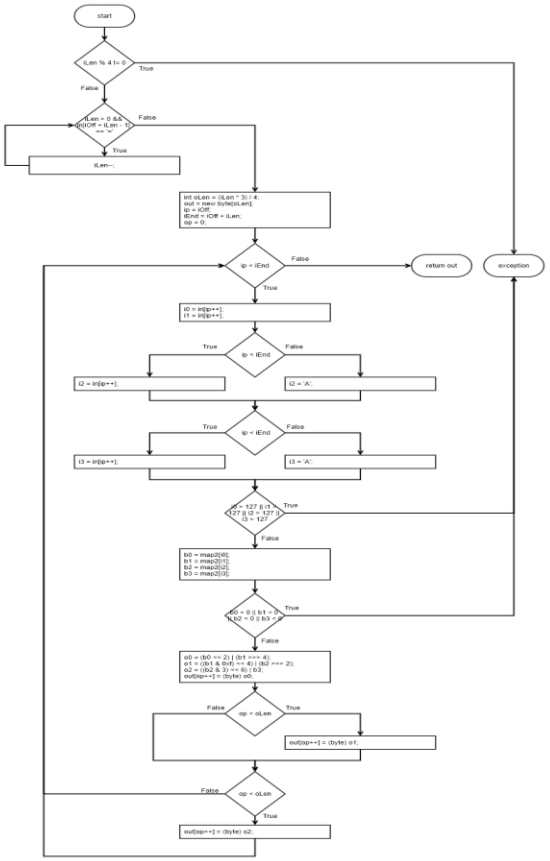
Source Code:

timesheet-master\src\main\java\timeSheet\util\properties\Base64Coder.java



```
106     public byte[] decode(char[] in, int iOff, int iLen) {
107         if (iLen % 4 != 0)
108             throw new IllegalArgumentException("Length of Base64 encoded input string is not a multiple of 4.");
109         while (iLen > 0 && in[iOff + iLen - 1] == '=') iLen--;
110         int oLen = (iLen * 3) / 4;
111         byte[] out = new byte[oLen];
112         int ip = iOff;
113         int iEnd = iOff + iLen;
114         int op = 0;
115         while (ip < iEnd) {
116             int i0 = in[ip++];
117             int i1 = in[ip++];
118             int i2 = ip < iEnd ? in[ip++] : 'A';
119             int i3 = ip < iEnd ? in[ip++] : 'A';
120             if (i0 > 127 || i1 > 127 || i2 > 127 || i3 > 127)
121                 throw new IllegalArgumentException("Illegal character in Base64 encoded data.");
122             int b0 = map2[i0];
123             int b1 = map2[i1];
124             int b2 = map2[i2];
125             int b3 = map2[i3];
126             if (b0 < 0 || b1 < 0 || b2 < 0 || b3 < 0)
127                 throw new IllegalArgumentException("Illegal character in Base64 encoded data.");
128             int o0 = (b0 << 2) | (b1 >>> 4);
129             int o1 = ((b1 & 0xf) << 4) | (b2 >>> 2);
130             int o2 = ((b2 & 3) << 6) | b3;
131             out[op++] = (byte) o0;
132             if (op < oLen) out[op++] = (byte) o1;
133             if (op < oLen) out[op++] = (byte) o2;
134         }
135         return out;
136     }
137 }
```

CFG:



Statement Coverage:

Exception cases are not covered under sir's guidance.

Test case#	Input	Expected Output	Comments/Remarks

1	In[] = ‘QUJD’ iOff = 0 iLen = 4	‘ABC’	No padding
2	In[] = ‘QQ==’ iOff = 0 iLen = 4	‘A’	Padded with ==

Branch Coverage:

Exception cases are not covered under sir’s guidance.

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	In[] = ‘QUJD’ iOff = 0 iLen = 4	‘ABC’	109F, 115TF, 118T, 119T, 132T, 133T
2	In[] = ‘QQ==’ iOff = 0	‘A’	109TF, 115TF, 118F, 119F, 132F, 133F

	iLen = 4		

Condition Coverage with Short Circuit Evaluation:

Exception cases are not covered under sir's guidance.

Test case#	Input	Expected Output	Comments/Remarks
1	In[] = 'QUJD' iOff = 0 iLen = 0	Empty String	109aF, 115F
2	In[] = 'QUJD' iOff = 0 iLen = 4	'ABC'	109aT, 109bF, 115TF, 118T, 119T, 132T, 133T
3	In[] = 'QQ==' iOff = 0 iLen = 4	'A'	109aT, 109bTF, 115TF, 118F, 119F, 132F, 133F

Boundary Interior:

Exception cases are not covered under sir's guidance.

Possible logical paths:

- A: 118T->119T-> 132T-> 133T
- B: 118T-> 119F-> 132T->133F
- C: 118F-> 119F-> 132T-> 133F

Test case#	Input	Expected Output	Comments/Remarks
1	In[] = 'QUJD' iOff = 0 iLen = 4	'ABC'	Covers Path A
2	In[] = 'QQ==' iOff = 0 iLen = 4	'A'	Covers Path B
3	In[] = 'QUI=' iOff = 0 iLen = 4	'AB'	Covers Path C

Loop Boundary:

Consider N=12 for loop. (Note that for valid input N-1 must be 8 and N+1 must be 16)

Test case#	Input	Expected Output	Comments/Remarks
1	In[] = 'QUJD' iOff = 0 iLen = 0	Empty String	Covers 115F
2	In[] = 'QUJD' iOff = 0 iLen = 4	'ABC'	Covers 115F once
3	In[] = 'QUJDREU=' iOff = 0 iLen = 8	'ABCDE'	Covers 115T for N-1
4	In[] = 'QUJDREVGRw==' 	'ABCDEFG'	Covers 115T for N

	iOff = 0 iLen = 12		
5	In[] = ‘QUJDREVGR0hJSg==’ iOff = 0 iLen = 16	‘ABCDEFGHIJ’	Covers 115T for N+1

Basis Path:

Edges - Nodes + 2 = 21 – 16 + 2 = 7

Path 1: 109F, 115F

Path 2: 109F, 115T, 118T, 119T, 132T, 133T

Path 3: 109T, 115F

Path 4: 109T, 115T, 118T, 119F, 132T, 133F

Path 5: 109T, 115T, 118F, 119F, 132F, 133F

Path 6: 109T, 115F, 118F, 119T, 132F, 133F

Path 7: 109T, 115F, 118F, 119F, 132F, 133T

Note that no logical path is possible to cause 119T while 118F. Same is case with 132F and 133T. Similarly, conditions in 132 and 133 also depend upon same factor as 118, 119 so it is not possible for 118T but 132F and vice versa. Furthermore, condition 109 also shares data dependency with 118, 119, 132, and 133. So Path 6 and 7 are not possible.

Test case#	Input	Expected Output	Comments/Remarks
1	In[] = 'QUJD' iOff = 0 iLen = 0	Empty String	Covers Path1
2	In[] = 'QUJD' iOff = 0 iLen = 4	'ABC'	Covers Path2
3	In[] = 'QQ==' iOff = 2 iLen = 4	Empty String	Covers Path3
4	In[] = 'QQ==' iOff = 0 iLen = 4	'A'	Covers Path5

5	In[] = 'QUI=' iOff = 0 iLen = 4	'AB'	Covers Path4

Data Flow Testing:

Exceptions cases not considered under sir's guidance

Variable #	Variable Name	Definitions	Uses
1	iLen	106, 109	109, 110, 113
2	oLen	110	111, 132, 133
3	Op	114, 131, 132, 133	131, 132, 133

Variable #	Variable Name	DU pairs
1	iLen	<106, 109>, <109, 109>, <106, 113>, <109, 113>, <106, 110>, <109, 110>
2	oLen	<110, 111>, <110, 132>, <110, 133>
3	Op	<114, 131>, <131, 132>, <131, 133>, <132, 133>

Test case#	Input	Expected Output	Comments/Remarks
1	In[] = 'QUJD' iOff = 0 iLen = 4	'ABC'	iLen = Covers <106, 109>, <106, 110>, <106, 113> oLen = Covers <110, 111>, <110, 132>, <110, 133> op = Covers <114, 131>, <131, 132>, <132, 133>
2	In[] = 'QQ== iOff = 0 iLen = 4	'A'	iLen = Covers <106, 109>, <106, 110>, <106, 113> oLen = Covers <110, 111>, <110, 132>, <110, 133> op = Covers <114, 131>, <131, 132>, <131, 133>

Function 5:

Source Code:

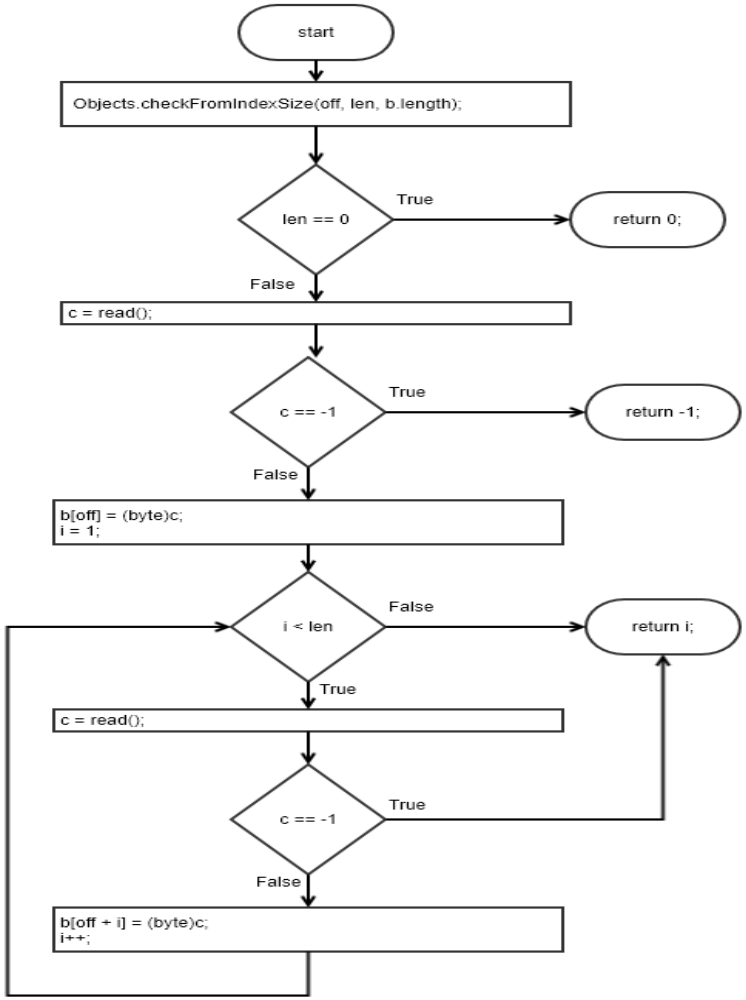
https://github.com/openjdk/jdk/blob/master/src/java.base/share/classes/java/io/InputStream.

Java

checkFromIndexSize and read are external APIs. checkFromIndexSize can be implemented as dummy stub while read is implemented as needed by each test case.

```java
278     public int read(byte b[], int off, int len) throws IOException {
279         Objects.checkFromIndexSize(off, len, b.length);
280         if (len == 0) {
281             return 0;
282         }
283 
284         int c = read();
285         if (c == -1) {
286             return -1;
287         }
288         b[off] = (byte)c;
289 
290         int i = 1;
291         try {
292             for (; i < len ; i++) {
293                 c = read();
294                 if (c == -1) {
295                     break;
296                 }
297                 b[off + i] = (byte)c;
298             }
299         } catch (IOException ee) {
300         }
301         return i;
302     }
```

CFG:



Statement Coverage:

Test case#	Input	Expected Output	Comments/Remarks
1	b[] = Empty Array off = 0 len = 3	3, b[] ='ABC'	External module API read() returns 'A', 'B', 'C' in consecutive calls.
2	b[] = Empty Array off = 0 len = 0	0, b[] = Empty Array	External module API read() is never called
3	b[] = Empty Array off = 0 len = 3	-1, b[] = Empty Array	External module API read() returns -1 to notify an error at first call.
4	b[] = Empty Array off = 0 len = 3	1, b[] = 'A'	External module API read() returns 'A', -1 in consecutive calls.

Branch Coverage:

Test case#	Input	Expected Output	Comments/Remarks
1	b[] = Empty Array off = 0 len = 3	3, b[] ='ABC'	External module API read() returns 'A', 'B', 'C' in consecutive calls. 280F, 285F, 292TF, 294F
2	b[] = Empty Array off = 0 len = 0	0, b[] = Empty Array	External module API read() is never called. 280T
3	b[] = Empty Array off = 0 len = 3	-1, b[] = Empty Array	External module API read() returns -1 to notify an error at first call. 280F, 285T
4	b[] = Empty Array off = 0 len = 3	1, b[] = 'A'	External module API read() returns 'A', -1 in consecutive calls. 280F, 285F, 292T, 294T

Condition Coverage with Short Circuit Evaluation:

Test case#	Input	Expected Output	Comments/Remarks
1	b[] = Empty Array off = 0 len = 3	3, b[] =‘ABC’	External module API read() returns ‘A’, ‘B’, ‘C’ in consecutive calls. 280F, 285F, 292TF, 294F
2	b[] = Empty Array off = 0 len = 0	0, b[] = Empty Array	External module API read() is never called. 280T
3	b[] = Empty Array off = 0 len = 3	-1, b[] = Empty Array	External module API read() returns -1 to notify an error at first call. 280F, 285T
4	b[] = Empty Array off = 0 len = 3	1, b[] = ‘A’	External module API read() returns ‘A’, -1 in consecutive calls. 280F, 285F, 292T, 294T

Boundary Interior:

Possible logical paths (depends upon successful or unsuccessful read, returned from stub function. Input does not effectively dictate the decision):

- 294T
- 294F

Test case#	Input	Expected Output	Comments/Remarks
1	b[] = Empty Array off = 0 len = 3	3, b[] =‘ABC’	External module API read() returns ‘A’, ‘B’, ‘C’ in consecutive calls. 294F
2	b[] = Empty Array off = 0 len = 3	1, b[] =‘A’	External module API read() returns ‘A’, ‘-1’ in consecutive calls. 294T

Loop Boundary:

Consider N=4 for loop boundary

Test case#	Input	Expected Output	Comments/Remarks
1	b[] = Empty Array off = 0 len = 1	1, b[] =‘A’	External module API read() returns ‘A’ in consecutive calls. Covers 292F
2	b[] = Empty Array off = 0 len = 2	2, b[] =‘AB’	External module API read() returns ‘A’, ‘B’ in consecutive calls. Covers 292T once
3	b[] = Empty Array off = 0 len = 4	4, b[] =‘ABCD’	External module API read() returns ‘A’, ‘B’, ‘C’, ‘D’ in consecutive calls. Covers 292T N-1 times
4	b[] = Empty Array off = 0 len = 2	4, b[] =‘ABCDE’	External module API read() returns ‘A’, ‘B’, ‘C’, ‘D’, ‘E’ in consecutive calls. Covers 292T N times
5	b[] = Empty Array off = 0	4, b[] =‘ABCDEF’	External module API read() returns ‘A’, ‘B’, ‘C’, ‘D’, ‘E’, ‘F’ in

	len = 2		consecutive calls. Covers 292T N+1 times

Basis Path:

Decision points + 1 = 4 + 1 = 5

Path 1: 280T

Path 2: 280F, 285T

Path 3: 280F, 285F, 292F

Path 4: 280F, 285F, 292TF, 294F

Path 5: 280F, 285F, 292T, 294T

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	b[] = Empty Array off = 0	3, b[] ='ABC'	External module API read() returns 'A', 'B', 'C' in consecutive calls. **Covers Path4**

	len = 3		
2	b[] = Empty Array off = 0 len = 0	0, b[] = Empty Array	External module API read() is never called. **Covers Path1**
3	b[] = Empty Array off = 0 len = 3	-1, b[] = Empty Array	External module API read() returns -1 to notify an error at first call. **Covers Path2**
4	b[] = Empty Array off = 0 len = 3	1, b[] = 'A'	External module API read() returns 'A', -1 in consecutive calls. **Covers Path5**
5	b[] = Empty Array off = 0 len = 1	1, b[] = 'A'	External module API read() returns 'A' in consecutive calls. **Covers Path3**

Data Flow Testing:

Variable #	Variable Name	Definitions	Uses
1	i	290, 292	292, 297
2	c	284, 293	285, 288, 294, 297
3	len	278	279, 292

Variable #	Variable Name	DU pairs
1	i	<290,292>, <290,297>, <292, 292>, <292,297>
2	c	<284,285>, <284,288>, <293,294>, <293,297>
3	len	<278, 279>, <278,292>

Test case#	Input	Expected Output	Comments/Remarks
1	b[] = Empty Array off = 0 len = 3	3, b[] ='ABC'	i = Covers <290,292>, <290,297>, <292, 292>, <292,297> c = Covers <284,285>, <284,288>,

			<293,294>, <293,297> len = Covers <278, 279>, <278,292>

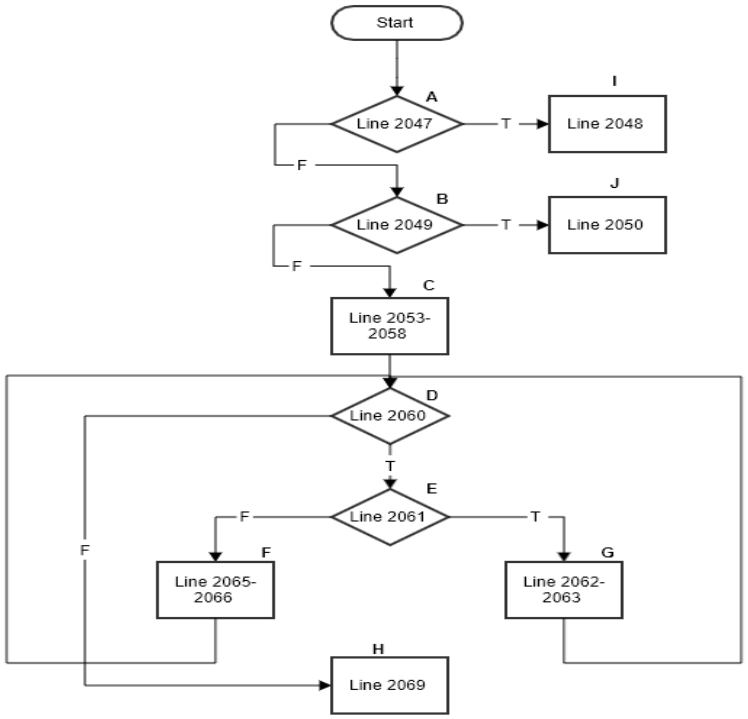
Function 6:

Source Code:

https://github.com/openjdk/jdk/tree/master/src/java.base/share/classes/java/math/ MutableBigInteger.java

```
2046    static int binaryGcd(int a, int b) {
2047        if (b == 0)
2048            return a;
2049        if (a == 0)
2050            return b;
2051
2052        // Right shift a & b till their last bits equal to 1.
2053        int aZeros = Integer.numberOfTrailingZeros(a);
2054        int bZeros = Integer.numberOfTrailingZeros(b);
2055        a >>>= aZeros;
2056        b >>>= bZeros;
2057
2058        int t = (aZeros < bZeros ? aZeros : bZeros);
2059
2060        while (a != b) {
2061            if ((a+0x80000000) > (b+0x80000000)) {  // a > b as unsigned
2062                a -= b;
2063                a >>>= Integer.numberOfTrailingZeros(a);
2064            } else {
2065                b -= a;
2066                b >>>= Integer.numberOfTrailingZeros(b);
2067            }
2068        }
2069        return a<<t;
2070    }
```

CFG:



.

Statement Coverage:

Test case#	Input	Expected Output	Comments/Remarks

1	a = 15 b = 0	15	Covers statement 2047-2048
2	a = 0 b =15	15	Covers statement 2049-2050
3	a = 98 b =56	14	Covers statement 2047,2049, 2051-2069

Branch Coverage:

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	a = 15 b = 0	15	Covers B2047T
2	a = 0 b =15	15	Covers B2049T, B2047F
3	a = 98 b =56	14	Covers B2047F, B2049F, B2060TF, B2061T

4	a = 56 b =98	14	Covers B2047F, B2049F, B2060TF, B2061F

Condition Coverage with Short Circuit Evaluation:

Test case#	Input	Expected Output	Comments/Remarks
1	a = 15 b = 0	15	Covers C2047T
2	a = 0 b =15	15	Covers C2049T, C2047F
3	a = 98 b =56	14	Covers C2047F, C2049F, C2060TF, C2061T
4	a = 56 b =98	14	Covers C2047F, C2049F, C2060TF, C2061F

Boundary Interior:

Test case#	Input	Expected Output	Comments/Remarks
1	a = 98 b =56	14	Covers boundary interior path DEG
2	a = 56 b =98	14	Covers boundary interior path DEF

Loop Boundary:

I choose loop upper bound = 5

Test case#	Input	Expected Output	Comments/Remarks
1	a = 12 b = 12	12	Loop is skipped entirely.
2	a = 4 b = 2	2	Loop is run only once

3	a = 6 b = 2	2	Loop is run twice.
4	a = 10 b = 2	2	Loop is run 4 times
5	a = 12 b = 2	2	Loop is run 5 times.
6	a = 14 b = 2	2	Loop is run 6 times.

Basis Path:

No. of Basis Paths = No. of decision points + 1

No. of Basis Paths = 4 + 1 = 5

Path 1: AI

Path 2: ABJ

Path 3: ABCDH

Path 4: ABCDEFH

Path 5: ABCDEGH

Test case#	Input	Expected Output	Comments/Remarks
1	a = 15 b = 0	15	Covers basis path AI
2	a = 0 b =15	15	Covers basis path ABJ
3	a = 12 b = 12	12	Covers basis path ABCDH
4	a = 2 b = 4	2	Covers basis path ABCDEFH
5	a = 4 b = 2	2	Covers basis path ABCDEFH

Data Flow Testing:

Variable #	Variable Name	Definitions	Uses
1	A	2046, 2055, 2062, 2063	2048, 2049, 2053, 2055, 2060, 2061, 2062, 2063, 2065, 2069
2	b	2046, 2056, 2065, 2066	2047, 2050, 2054, 2056, 2060, 2061, 2062, 2065, 2066
3	aZeros	2053	2055, 2058

Variable #	Variable Name	DU pairs
1	a	<2046, 2048> <2046, 2049> <2046, 2053> <2046, 2055> <2055, 2060> <2055, 2061> <2055, 2062> <2055, 2065> <2055, 2069> <2062, 2063> <2063, 2060> <2063, 2061> <2063, 2062> <2063, 2069>
2	b	<2046, 2047> <2046, 2050> <2046, 2054> <2046, 2056> <2056, 2060> <2056, 2061>

		<2056, 2062> <2056, 2065> <2065, 2066> <2066, 2060> <2066, 2061> <2066, 2062>
3	aZeros	<2053, 2055> <2053, 2058>

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	a = 15 b = 0	15	For a covers <2046, 2048> For b covers <2046, 2047>
2	a = 0 b =15	15	For a covers <2046, 2049> For b covers <2046, 2047> <2046, 2050>

3	a = 12 b = 12	12	For a covers: <2046, 2049> <2046, 2055> <2055, 2060> <2055, 2069> For b covers: <2046, 2047> <2046, 2056> <2056, 2060> For aZeros covers: <2053, 2055> <2053, 2058>
4	a = 98 b =56	14	For a covers <2046, 2049> <2046, 2053>

			<2046, 2055> <2055, 2060> <2055, 2061> <2055, 2062> <2062, 2063> <2063, 2060> <2063, 2061> <2063, 2062> <2063, 2069> For b covers <2046, 2047> <2046, 2054> <2046, 2056> <2056, 2060> <2056, 2061> <2056, 2062> For aZeros covers: <2053, 2055>

			<2053, 2058>
5	a = 56 b =98	14	For a covers <2046, 2049> <2046, 2053> <2046, 2055> <2055, 2060> <2055, 2061> <2055, 2065> <2055, 2069> For b covers <2046, 2047> <2046, 2054> <2046, 2056> <2056, 2060> <2056, 2061> <2056, 2065> <2065, 2066>

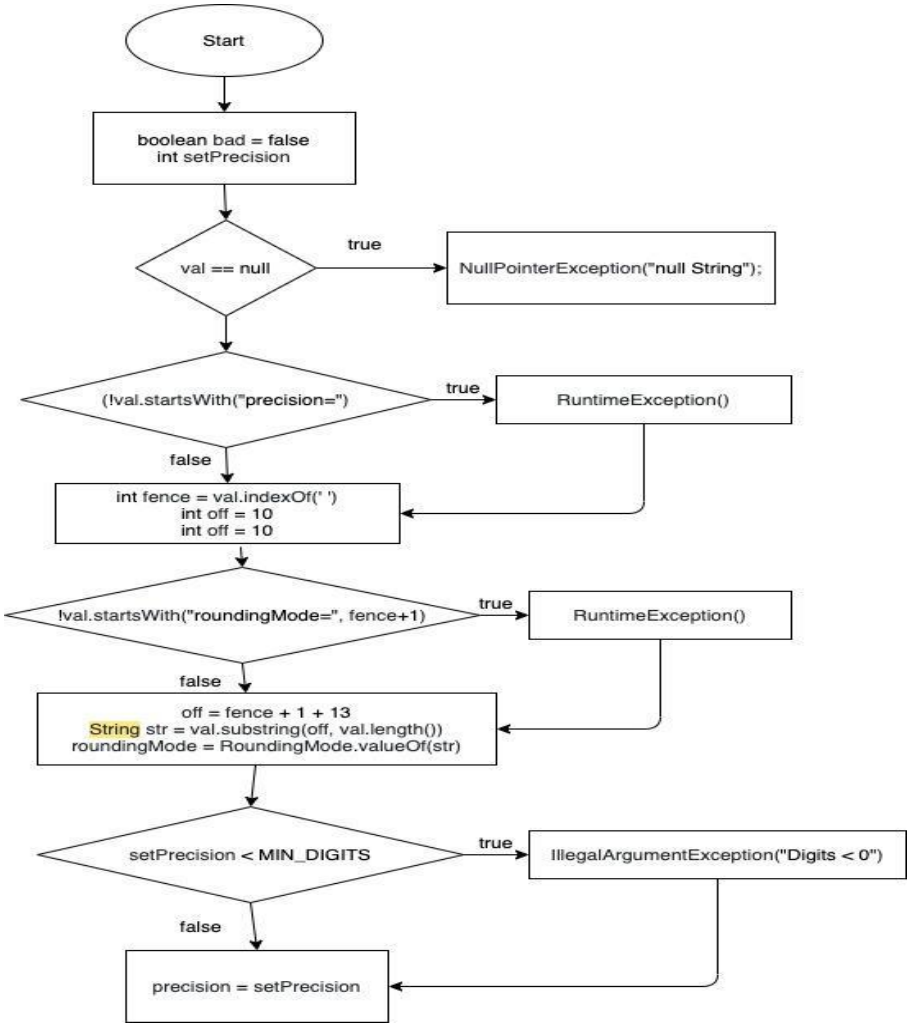
			<2066, 2060> <2066, 2061> <2066, 2062> For aZeros covers: <2053, 2055> <2053, 2058>

Function 8:

Source Code:

```
183     public MathContext(String val) {
184         boolean bad = false;
185         int setPrecision;
186         if (val == null)
187             throw new NullPointerException("null String");
188         try { // any error here is a string format problem
189             if (!val.startsWith("precision=")) throw new RuntimeException();
190             int fence = val.indexOf(' ');    // could be -1
191             int off = 10;                    // where value starts
192             setPrecision = Integer.parseInt(val.substring(10, fence));
193 
194             if (!val.startsWith("roundingMode=", fence+1))
195                 throw new RuntimeException();
196             off = fence + 1 + 13;
197             String str = val.substring(off, val.length());
198             roundingMode = RoundingMode.valueOf(str);
199         } catch (RuntimeException re) {
200             throw new IllegalArgumentException("bad string format");
201         }
202 
203         if (setPrecision < MIN_DIGITS)
204             throw new IllegalArgumentException("Digits < 0");
205         // the other parameters cannot be invalid if we got here
206         precision = setPrecision;
207     }
```

CFG:


Start
boolean bad = false
int setPrecision
val == null
true
NullPointerException("null String");
(!val.startsWith("precision=")
true
RuntimeException()
false
int fence = val.indexOf(' ')
int off = 10
int off = 10
!val.startsWith("roundingMode=", fence+1)
true
RuntimeException()
false
off = fence + 1 + 13
String str = val.substring(off, val.length())
roundingMode = RoundingMode.valueOf(str)
setPrecision < MIN_DIGITS
true
IllegalArgumentException("Digits < 0")
false
precision = setPrecision

Statement Coverage:

Test case#	Input	Expected Output	Comments/Remarks
1	null	exception	Covered 184, 185, 186, 187
2	'ThisString'	exception	Covered 184, 185, 186, 188, 189
3	'precision=12 12'	exception	Covered 184, 185, 186, 188, 190, 191, 192, 194, 195
4	roundingMode =12 12'	exception	Covered 184, 185, 186, 188, 189

Branch Coverage:

Test case#	Input	Expected Output	Comments/Remarks

1	(null)	exception	Covered B186(True)
2	‘ThisString’	exception	Covered B186(False), B189(True)
3	‘precision=12 12’	exception	Covered B186(False), B189(False), B194(True)
4	‘roundingMode =12 12’	Exception	Covered B186(False), B189(True)

Condition Coverage with Short Circuit Evaluation:

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	(null)	exception	Covered C186(True)
2	‘ThisString’	exception	Covered C186(False), C189(True)

3	‘precision=12 12’	exception	Covered C186(False), C189(False), C194(True)
4	‘roundingMode =12 12’	exception	Covered C186(False), C189(True)

Boundary Interior:

No Loop in the program.

Loop Boundary:

No Loop in the program.

Basis Path:

No of decision points = 4

No. of basis path = No of decision points +1 = 4+1 = 5

Path 1:

183, 184, 185, 186, 203, 206

Path 2:

183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 196, 197, 198, 203, 206

Path 3:

183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 194, 195, 196, 197, 198, 199, 200, 203, 206

Path 4:

183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 194, 195, 196, 197, 198, 199, 200, 203, 204, 206

Path 5:

183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 194, 195, 196, 197, 198, 199, 200, 203, 204, 206

Test case#	Input	Expected Output	Comments/Remarks
1	null	Exception	Covers Path 1
2	'precision=12 12'	Exception	Covers Path 3
3	'roundingMode =12 12'	Exception	Covers Path 2

4	‘abcdef’	Exception	Covers Path 5
5	‘’	Exception	Covers Path 4

Data Flow Testing:

Variable #	Variable Name	Definitions	Uses
1	Val	183	186,189,190,192,197
2	setPrecision	185,192	203,206
3	Fence	190	192,194

Variable #	Variable Name	DU pairs
1	Val	<183,186>,<183,189>,<183,190>,<183,192>,<183,197>
2	setPrecision	<192,203>,<192,206>
3	Fence	<190,192>,<190,194>

Test case#	Input	Expected Output	Comments/Remarks

1	‘ThisString’	Exception	For Val: <183,186>,<183,189> For setPrecision: Not used For Fence: Not used because it does not contains ‘precision=’ at start
2	‘precision=12 12’	Exception	For Val: <183,186>,<183,189>,<183,190>,<183,192> For setPrecision: Not used For Fence:

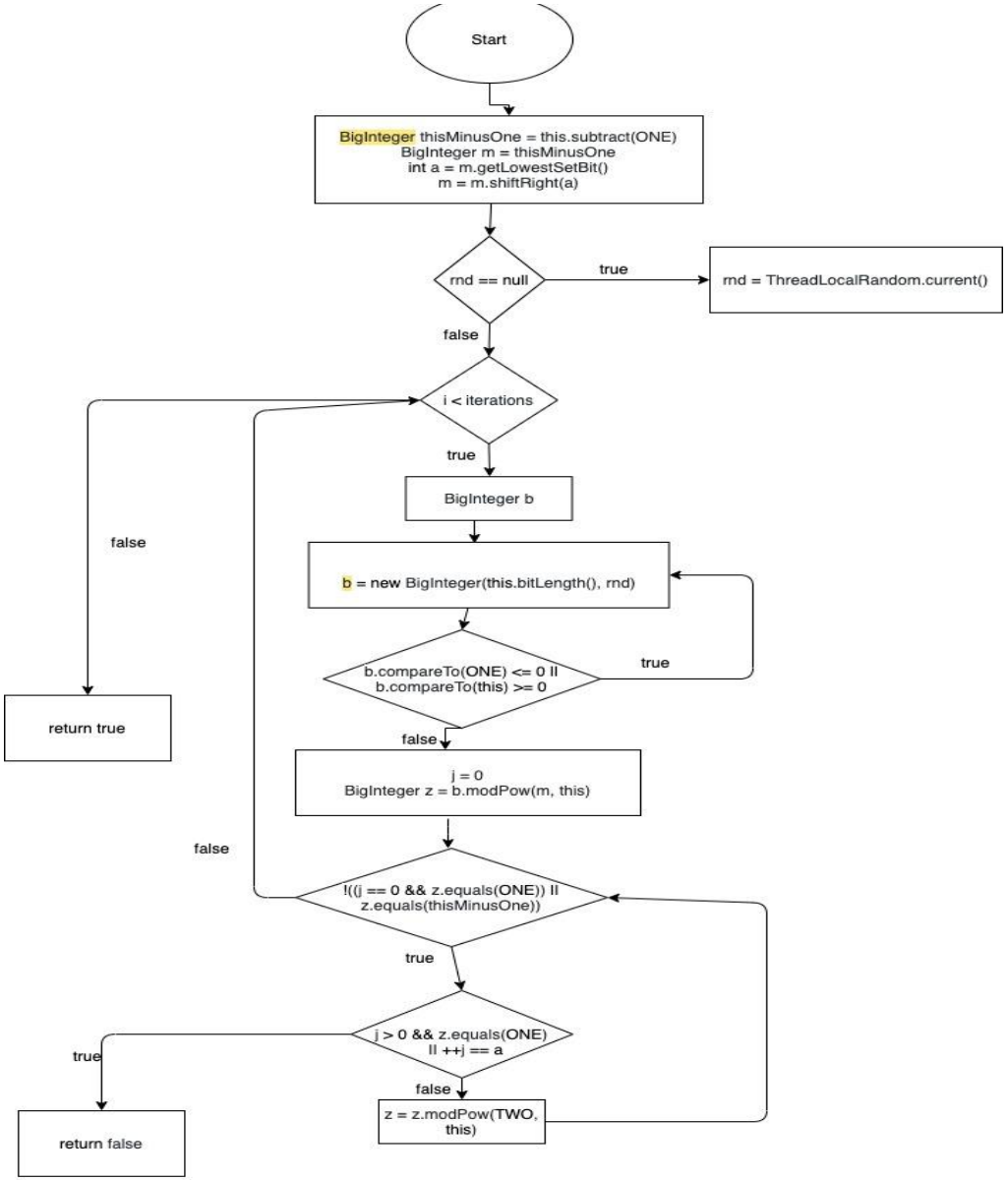
			<190,192>,<190,194> It returns exception because when next if executes it'll not find 'roundingMode=' at start

Function 9

Source Code:

```
1101      private boolean passesMillerRabin(int iterations, Random rnd) {
1102          // Find a and m such that m is odd and this == 1 + 2**a * m
1103          BigInteger thisMinusOne = this.subtract(ONE);
1104          BigInteger m = thisMinusOne;
1105          int a = m.getLowestSetBit();
1106          m = m.shiftRight(a);
1107
1108          // Do the tests
1109          if (rnd == null) {
1110              rnd = ThreadLocalRandom.current();
1111          }
1112          for (int i=0; i < iterations; i++) {
1113              // Generate a uniform random on (1, this)
1114              BigInteger b;
1115              do {
1116                  b = new BigInteger(this.bitLength(), rnd);
1117              } while (b.compareTo(ONE) <= 0 || b.compareTo(this) >= 0);
1118
1119              int j = 0;
1120              BigInteger z = b.modPow(m, this);
1121              while (!((j == 0 && z.equals(ONE)) || z.equals(thisMinusOne))) {
1122                  if (j > 0 && z.equals(ONE) || ++j == a)
1123                      return false;
1124                  z = z.modPow(TWO, this);
1125              }
1126          }
1127          return true;
1128      }
```

CFG:


Start
BigInteger thisMinusOne = this.subtract(ONE)
BigInteger m = thisMinusOne
int a = m.getLowestSetBit()
m = m.shiftRight(a)
rnd == null
true
rnd = ThreadLocalRandom.current()
false
i < iterations
true
BigInteger b
false
b = new BigInteger(this.bitLength(), rnd)
b.compareTo(ONE) <= 0 ||
b.compareTo(this) >= 0
true
return true
false
j = 0
BigInteger z = b.modPow(m, this)
false
!((j == 0 && z.equals(ONE)) ||
z.equals(thisMinusOne))
true
j > 0 && z.equals(ONE)
|| ++j == a
true
false
return false
z = z.modPow(TWO,
this)

Statement Coverage:

Test case#	Input	Expected Output	Comments/Remarks
1	(4, null)	true	covers 1103,1104,1105,,1106,1109,1110, 1111,1112,1113,1114-1128
2	(0,4)	true	covers 1103,1104,1105,,1106,1109,1112, 1127
3	(null,null)	true	covers 1103-1111,1112
4	(7,9)	false	Covered 1103-1111,1112-1123

Branch Coverage:

Test case#	Input	Expected Output	Comments/Remarks

1	(4, null)	true	covers B1109(T), B1112(T), B1117(T), B1121(T)
2	(0, 4)	true	covers B1109(F), B1112(F)
3	(null, null)		
4	(7,9)	False	covers B1109(T) B1112(T), B1117(T), B1121(T), B1122(T)

Condition Coverage with Short Circuit Evaluation:

Test case#	Input	Expected Output	Comments/Remarks
1	(4, null)	true	covers C1109(T), C1112(T), C1117(T), C1121(T)
2	(0, 4)	true	covers C1109(F), C1112(F)
3	(null, null)	no output	covers C1109(T), C1112(Crash)
4	(7,9)	False	covers C1109(T), C1112(T), C1117(T), C1121(T), C1122(T)

Boundary Interior:

Below we are taking line numbers to execute boundary interior.

1112 -> 1114

1112 -> 1114 -> 1115

1112 -> 1114 -> 1116 -> 1117

1112 -> 1114 -> 1116 -> 1117 -> 1116

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122 -> 1123

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122 -> 1124

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122 -> 1124 -> 1121

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122 -> 1124 -> 1121 -> 1127

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	(4, null)	True	Covers 1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122

			-> 1124 -> 1121 -> 1126
2	(0, 4)	True	Covers 1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122 -> 1124 -> 1121 -> 1127

Loop Boundary:

Test case#	Input	Expected Output	Comments/Remarks
1	(0,2)	True	Covers 1109T When the loop will not execute
2	(1,2)	True	Covers 1112T once
3	(5,2)	False	Covers 1112T more than one passes

Basis Path:

No of decision points = 3

No. of basis path = No of decision points +1 = 3+1 = 4

Path 1:

1101, 1103, 1104, 1105, 1106, 1127

Path 2:

1101, 1103, 1104, 1105, 1106, 1109, 1110, 1127

Path 3:

1101, 1103, 1104, 1105, 1106, 1109, 1110, 1112, 1113, 1114, 1115, 1116, 1117, 1119, 1120, 1127

Path 4:

1101, 1103, 1104, 1105, 1106, 1109, 1110, 1112, 1113, 1114, 1115, 1116, 1117, 1119, 1120, 1121, 1122, 1123, 1124, 1127

Test case#	**Input**	**Expected Output**	**Comments/Remarks**
1	(4, null)	True	Covers Path 1

2	(0, 4)	True	Covers Path 2
3	(null, null)	True	Covers Path 3
4	(7,9)	False	Covers Path 4

Data Flow Testing:

Variable #	Variable Name	Definitions	Uses
1	iterations	1101	1112
2	Rnd	1101,1110	1109,1116
3	A	1105	1106

Variable #	Variable Name	DU pairs
1	iterations	<1101,1112>
2	Rnd	<1101,1109>,<1110,1116>
3	A	<1105,1106>

Test case#	Input	Expected Output	Comments/Remarks
1	(4, null)	True	For iterations: Not defined and used For Rnd: <1101,1109>,<1110,1116> For A: <1105,1106> It returns true second null value is handled in function
2	(7,9)	False	For iterations: <1101,1112> For Rnd: <1101,1109>,<1110,1116> For A:

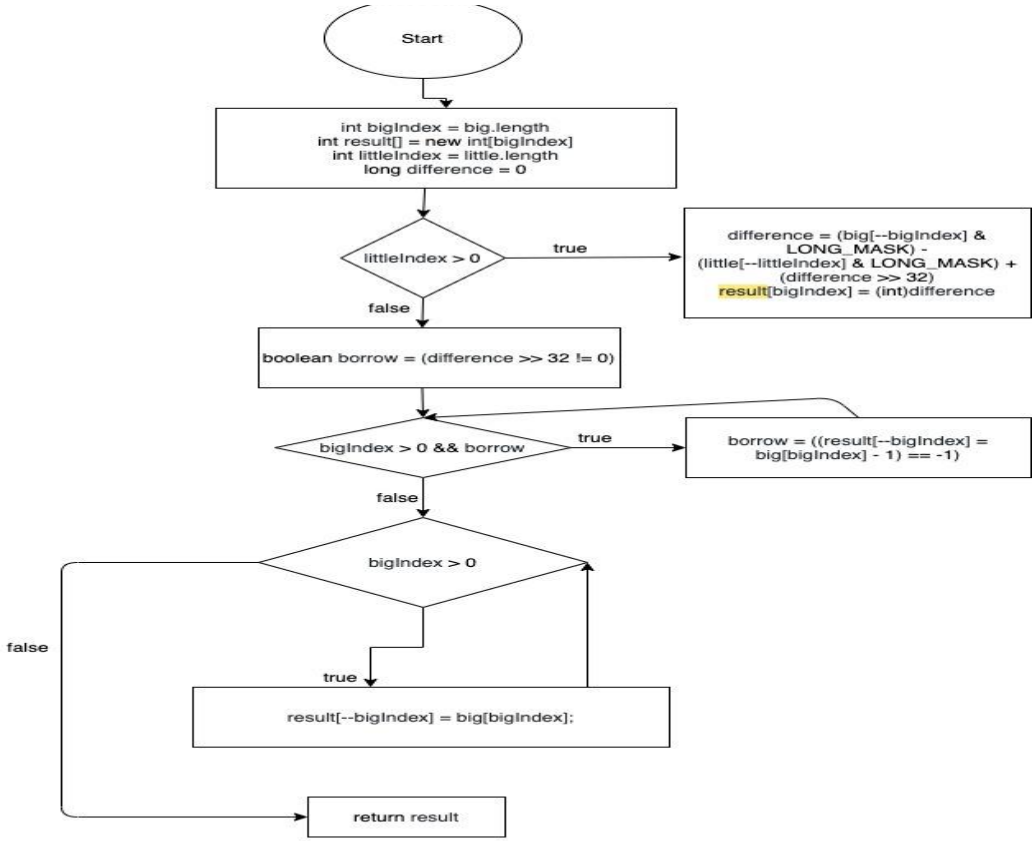
			<1105,1106> It returns the result false due to its values

Function 10:

Source Code:

```
1548      private static int[] subtract(int[] big, int[] little) {
1549          int bigIndex = big.length;
1550          int result[] = new int[bigIndex];
1551          int littleIndex = little.length;
1552          long difference = 0;
1553
1554          // Subtract common parts of both numbers
1555          while (littleIndex > 0) {
1556              difference = (big[--bigIndex] & LONG_MASK) -
1557                           (little[--littleIndex] & LONG_MASK) +
1558                           (difference >> 32);
1559              result[bigIndex] = (int)difference;
1560          }
1561
1562          // Subtract remainder of longer number while borrow propagates
1563          boolean borrow = (difference >> 32 != 0);
1564          while (bigIndex > 0 && borrow)
1565              borrow = ((result[--bigIndex] = big[bigIndex] - 1) == -1);
1566
1567          // Copy remainder of longer number
1568          while (bigIndex > 0)
1569              result[--bigIndex] = big[bigIndex];
1570
1571          return result;
1572      }
1573
```

CFG:


Start
int bigIndex = big.length
int result[] = new int[bigIndex]
int littleIndex = little.length
long difference = 0
littleIndex > 0
true
difference = (big[--bigIndex] & LONG_MASK) - (little[--littleIndex] & LONG_MASK) + (difference >> 32)
result[bigIndex] = (int)difference
false
boolean borrow = (difference >> 32 != 0)
bigIndex > 0 && borrow
true
borrow = ((result[--bigIndex] = big[bigIndex] - 1) == -1)
false
bigIndex > 0
false
true
result[--bigIndex] = big[bigIndex];
return result

Statement Coverage:

Test case#	Input	Expected Output	Comments/Remarks
1	x = {10,20} y = {30,40}	[-21,20]	covers 1549, 1550, 1551, 1552, 1553, 1555, 1563,1564, 1565, 1568
2	x={10,20} y = {}	[10,20]	covers 1549, 1550, 1551, 1552, 1553, 1555, 1563,1564, 1565, 1568, 1569
3	x = {} y = {30, 40}	[30, 40]	2nd empty array case is not handled

Branch Coverage:

Test case#	Input	Expected Output	Comments/Remarks
1	x = {10, 20} y = {30, 40}	[-21,20]	covers B1555T, B1564T, B1568T
2	x = {10,20} y = {}	[10,20]	covers B1555F, B1564T, B1568T
3	x = {} y = {30, 40}	[30, 40]	covers B1555F, B1564F, B1568F

Condition Coverage with Short Circuit Evaluation:

Test case#	Input	Expected Output	Comments/Remarks
1	x = {10,20}; y = {30,40}	[-21,20]	covers C1555T, C1564T, C1568T

2	x={10,20} y = {}	[10,20]	covers C1555F, C1564T, C1568T
3	x ={} y = {30, 40}	[30, 40]	covers C1555F, C1564F, C1568F

Boundary Interior:

Loop 1:

1555 -> 1556

1555 -> 1556 -> 1557

1555 -> 1556 -> 1557 -> 1558

1555 -> 1556 -> 1557 -> 1558 -> 1559

1555 -> 1556 -> 1557 -> 1558 -> 1559 -> 1555

Loop 2:

1564 -> 1565

1564 -> 1565 - 1564

Loop 3:

1568 -> 1569

1568 -> 1569 -> 1568

Test case#	Input	Expected Output	Comments/Remarks
1	x = {10,20} y = {30,40}	[-21,20]	Covers Loop 2 Covers Loop 1
2	x={10,20} y = {}	[10,20]	Covers Loop 2 Covers Loop 3

Loop Boundary:

Test case#	Input	Expected Output	Comments/Remarks
1	([0,2], [])	[0,2]	Covers:

			Loop 1: 1555T Loop 2: 1564T Loop 3: 1568T When the loop will not execute
2	([5],[2])	[2,4]	loop 1: 1555T loop 2: 1564T loop 3: 1568T Only one iteration
3	([10,20], [30,40])	[-21,20]	loop 1: littleIndex > 0 True

			loop 2: bigIndex > 0 True loop 3: bigIndex > 0 True more than one passes

Basis Path:

No of decision points = 4

No. of basis path = No of decision points +1 = 4+1 = 5

Path 1:

1548, 1549, 1550, 1551, 1552, 1555, 1556, 1557, 1558, 1559, 1563, 1571

Path 2:

1548, 1549, 1550, 1551, 1552, 1563, 1564, 1565, 1571

Path 3:

1548, 1549, 1550, 1551, 1552, 1555, 1556, 1557, 1558, 1559, 1563, 1564, 1565, 1568, 1569, 1571

Path 4:

1548, 1549, 1550, 1551, 1552, 1555, 1556, 1557, 1558, 1559, 1563, 1568, 1569, 1571

Test case#	Input	Expected Output	Comments/Remarks
1	x = {10,20} y = {30,40}	[-21,20]	Covers Path 3
2	x={10,20} y = {}	[10,20]	Covers Path 2
3	x={} y = {10,20}	Exception	Covers Path 1
4	x={10,20} y={30,40,50}	[-26,35]	Covers Path 4

Data Flow Testing:

Variable #	Variable Name	Definitions	Uses
1	big	1548	1549, 1556, 1565, 1569
2	little	1548	1551,1556
3	borrow	1563,1565	1564

Variable #	Variable Name	DU pairs
1	big	<1548,1549>,<1548,1549><1548,1556><1565,1569>
2	little	<1548,1551>,<1548,1556>
3	borrow	<1563,1564>

Test case#	Input	Output	Expected Output	Pass/Fail	Comments/Remarks
1	x = {10, 20} y = {30, 40}	[-21,20]	[-21,20]	Pass	For big covers <1548,1549>, <1565,1569>

					For little covers <1548,1551>, <1548,1556> For borrow covers <1563,1564> It returns true second null value is handled in function
2	x={10,20} y = {}	[10,20]	[10,20]	Pass	For big covers <1548,1549>, <1565,1569> For little covers <1548,1551>, <1548,1556> For borrow covers <1563,1564> It returns the result false

					due to its values

7. List of Test Cases that you created because you think they are important; otherwise none of the formal techniques required you to create them

This test case is for use case 7.

Orthogonal array did not return this combination but it was important to check the functionality of use case 7.

Test Case #	Inputs	Expected Output	Actual Output	Test Result	Test Comments (Orthognal Array Row reference)
1	Log 5 paid hours for active, regular and non-salaried employee. Go to Report Section to view report.	5 hours should be seen in the adp report.	5 hours are reflected in the adp report.	Pass	No such combination was given by orthogonal array.

8. Summary

Overall statistics:

The web application has very limited functionality.
The Use case 2, 11 have large ratio of failed test cases when executed with different test case variations.
Other use cases doesn't have that much failure.

Opinion about the quality of the system:

1. The system is very poorly designed.
2. System has very limited functionality.
3. Many requirements are missed.
4. Very poor exception handling is added for functionalities like time calculation, Hours worked etc.
5. Very limited check on the inputs.

Number of use cases:

We have identified 11 use cases in the project.

Following are the use cases for black box testing:

1. Wage can only be double (float) values.
2. Calculate hours worked for non-salaried and non-admin person.
3. Regular employee cannot log time for non-salaried person.
4. Approval of timesheet by timesheet approver.
5. Non-salaried person can log his own working time and send for approval.
6. A non-salaried and non-regular cannot approve his own time-sheet.
7. Only paid hour type shall appear in ADP report.
8. Employees added in ADP report shall have all combinations of employee properties. (Salaried, active, role, group).
9. Employees edit in ADP report shall have all combinations of employee properties.
10. Approved and Delete hours for employees by admin.
11. Date Hired cannot be greater than Full Time Date.

9. Role/Responsibilities of each team member.

Black box Testing Contribution

Danish:

3. Setup and Run the web application, resolved all errors to run the project successfully.
4. Identified Use case 1,5,6,8 and wrote test cases for them.

Abu Bakar:

3. Compiled final reports for all submissions and submitted them.
4. Identified Use case 2,3,4,7 and wrote test cases for them.

Awais:

2. Use case 9,10,11 and wrote test cases for them.

Musa Khan:

No Contribution.

White box Testing Contribution

Danish:

1. Setup and Run the web application, resolved all errors to run the project successfully.
2. Kept the repository updated with tools and reports.
3. Wrote test cases for these func 1, 4 , 5 in white box submissions.

Abu Bakar:

1. Documented the environment setup.
2. Compiled final reports for all submissions and submitted them.
3. Wrote test cases for these func 2,3,6 in white box submissions.

Awais:

1. Wrote test cases for these func 8,9,10 in white box submissions.

Musa Khan:

1. No Contribution.