Exercise:

1. Retrieve the name and address of all employees who work for the 'Research' department
   RESEARCH_DEPT ← $SELECT_{Dname = 'Research'}$(DEPARTMENT)
   RESULT ← $PROEJCT_{Fname, Minit, Lname, Address}$ (EMPLOYEE $JOIN_{Dno = Dnumber}$ RESEARCH_DEPT)

2. For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birth date.
   STAFFORD_PROJ ← $SELECT_{Plocation = 'Stafford'}$(PROJECT)
   MANAGER ← $PROJECT_{Pnumber, Dnumber, Mgr\_ssn}$(STAFFORD_PROJ $JOIN_{Dnum = Dnumber}$ DEPARTMENT)
   RESULT ← $PROJECT_{Pnumber, Dnumber, Lname, Address, BirthDate}$(MANAGER $JOIN_{Mgr\_ssn = SSN}$ EMPLOYEE)

   OR

   PROJ_DEPT ← PROJECT $JOIN_{Dnum = Dnumber}$ DEPARTMENT
   MANAGER← $PROJECT_{Pnumber, Dnumber, Mgr\_ssn}$ ($SELECT_{Plocation = 'Stafford'}$(PROJ_DEPT))
   RESULT ← $PROJECT_{Pnumber, Dnumber, Lname, Address, BirthDate}$(MANAGER $JOIN_{Mgr\_ssn = SSN}$ EMPLOYEE)

   The 1st approach is more efficient because it reduces the size of relations that participate in JOIN operation. Remember, the cost of JOIN/CARTESIAN operation is high. So if possible, please reduce its size before join operation.

3. Find the names of employees who work on ALL the projects controlled by department number 5
   a) Get Pno of all projects controlled by department 5
      $PROJ5_{Pno}$ ← $PROJECT_{Pnumber}$($SELECT_{Dnum = 5}$(PROJECT))
   b) Get all employees and projects they are working on
      EMP_PROJ ← $PROJECT_{Essn, Pno}$(WORKS_ON)
   c) Get SSN of all employees who works on all projects controlled by department 5
      EMP_PROJ5 ← EMP_PROJ / PROJ5
   d) Get name of these employees
      RESULT ← $PROEJCT_{Fname, Minit, Lname}$(EMPLOYEE $JOIN_{Ssn = Essn}$ EMP_PROJ5)

4. Make a list of project numbers for projects that involve an employee whose last name is 'Smith', either as a worker or as a manager of the department that controls the project.
   a) Get project # for projects involving employee with last name 'Smith' as worker
      a.1) get SSN of employees with last name 'Smith'
      SMITH_SSN ← $PROJECT_{SSN}$($SELECT_{Lname='Smith'}$(EMPLOYEE))
      a.2) get project # involving SMITH_SSN
      WORKER_PRJ ← $PROJECT_{Pno}$(SMITH_SSN $JOIN_{SSN = ESSN}$ WORKS_ON)
   b) Get project # for projects involving employee with last name 'Smith' as manager
      b.1) Get department # managed by some smith

DEPT_SMITH ← $PROJECT_{Dnumber}$(SMITH_SSN $JOIN_{SSN = Mgr\_ssn}$ DEPARTMENT)

b.2) Get project # controlled by department in DEPT_SMITH

MANGER_PRJ ← $PROJECT_{Pnumber}$(DEPT_SMITH $JOIN_{Dnumber = Dnum}$ PROJECT)

c) Union of the two results

RESULT ← WORKER_PRJ + MANAGER_PRJ

5. Retrieve the names of employees who have no dependents.
   a) Get ssn of all employees

      ALL_EMP ← $PROJECT_{SSN}$(EMPLOYEE)
   b) Get ssn of all employees who have dependent

      DEP_EMP ← $PROJECT_{ESSN}$(DEPENDENT)
   c) Get ssn of all employees who have NO dependent

      EMP_NO ← ALL_EMP – DEP_EMP
   d) Get name of all employees who have NO dependent

      RESULT ← $PROEJCT_{Fname, Minit, Lname}$(EMPLOYEE $JOIN_{EMPLOYEE.Ssn =EMP\_NO. Ssn}$ EMP_NO)

7. List the names of managers who have at least one dependent

MGR_SSN ← $PROJECT_{Mgr\_ssn}$(DEPARTMENT)

EMP_DEP ← $PROJECT_{ESsn}$(DEPENDENT)

RESULT ← $PROJECT_{Lname}$((MGR_SSN INTERSECT EMP_DEP) $JOIN_{Mgr\_ssn}$ EMPLOYEE)

5. List the names of all employees with two or more dependents

$DEP\_NUM_{Essn,num}$ ← $_{ESsn}F_{COUNT(Essn)}$(DEPENDENT)

RESULT ← $PROJECT_{Fname,Minit,Lname}$(SELECT$num_{>=2}$(DEP_NUM) $JOIN_{Essn=Ssn}$ EMPLOYEE)