Mid Exam Report

Distributed and Parallel System

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1. Project Overview

Application Description

Task Manager Pro is a full-stack web application that allows users to manage their daily tasks efficiently. The application consists of:

- **Frontend:** React.js application with modern UI/UX
- **Backend:** Node.js Express API with RESTful endpoints
- **Database:** MongoDB for data persistence
- **Containerization:** Docker and Docker Compose for deployment

Key Features

- ☑ Add new tasks
- ☑ Mark tasks as complete/incomplete
- ☑ Delete tasks
- ☑ Filter tasks (All, Active, Completed)
- ☑ Real-time task statistics
- ☑ Responsive design
- ☑ Health check endpoints

2. Technology Stack

Frontend

- **Framework:** React.js 18.2.0
- **Build Tool:** Vite 4.4.5
- **HTTP Client:** Axios 1.6.0
- **Styling:** Custom CSS with modern design

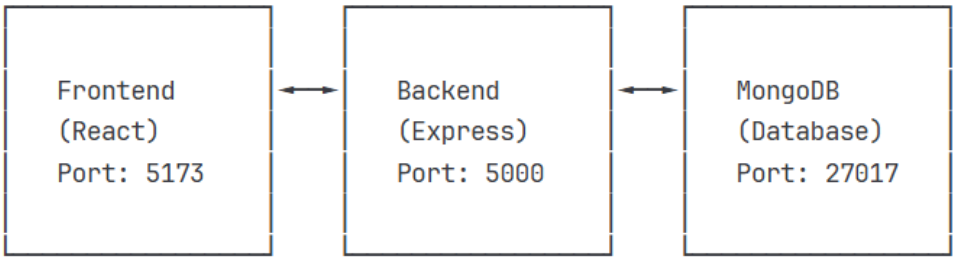
Backend

- **Runtime:** Node.js 18
- **Framework:** Express.js 4.18.2
- **Database:** MongoDB with Mongoose ODM
- **Additional:** CORS, dotenv for environment variables

Containerization

- **Container Platform:** Docker
- **Orchestration:** Docker Compose
- **Base Images:** Node.js 18 Alpine, MongoDB 7.0

3. Application Architecture



4. Project Structure

```
task-manager-pro/
├── frontend/
│   ├── src/
│   │   ├── App.jsx
│   │   └── App.css
│   ├── package.json
│   ├── vite.config.js
│   └── Dockerfile
├── backend/
│   ├── server.js
│   ├── healthcheck.js
│   ├── package.json
│   └── Dockerfile
└── docker-compose.yml
```

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5. Docker Implementation

Frontend Dockerfile

The frontend Dockerfile uses Node.js 18 Alpine image for lightweight deployment:

- Installs dependencies using npm
- Exposes port 5173
- Runs Vite development server with host configuration

Backend Dockerfile

The backend Dockerfile includes security best practices:

- Uses Node.js 18 Alpine base image
- Creates non-root user for security
- Implements health check using custom script
- Exposes port 5000

Docker Compose Configuration

The docker-compose.yml orchestrates three services:

- **MongoDB:** Database service with health check
- **Backend:** API service dependent on MongoDB
- **Frontend:** React app dependent on Backend

6. Step-by-Step Deployment Guide

Prerequisites

- Docker installed on your system
- Docker Compose installed
- Git for version control

Step 1: Clone/Setup Project Structure

```
bash

# Create project directory

mkdir task-manager-pro

cd task-manager-pro


# Create subdirectories

mkdir frontend backend
```

Step 2: Setup Frontend

```
bash

cd frontend

# Create all frontend files (App.jsx, App.css, package.json, etc.)

# Create Dockerfile
```

Step 3: Setup Backend

```bash
cd ../backend
# Create all backend files (server.js, package.json, etc.)
# Create Dockerfile
```

Step 4: Create Docker Compose

```bash
cd ..
# Create docker-compose.yml in root directory
```

Step 5: Build and Deploy

```bash
# Build and start all services
docker-compose up --build

# Run in detached mode
docker-compose up -d --build
```

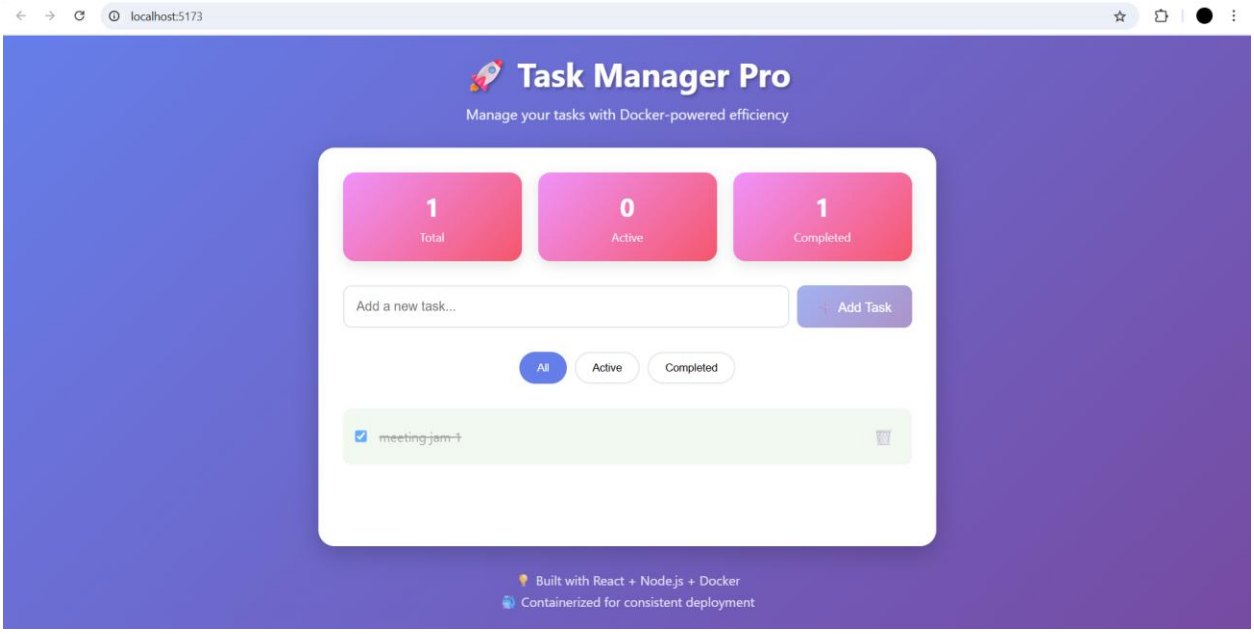
Step 6: Verify Deployment

```bash
# Check running containers
docker-compose ps

# View logs
docker-compose logs

# Test endpoints
curl http://localhost:5000/api/health
```

---

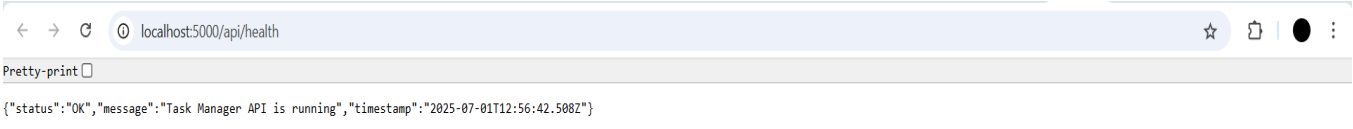
7. Screenshots

Application Interface



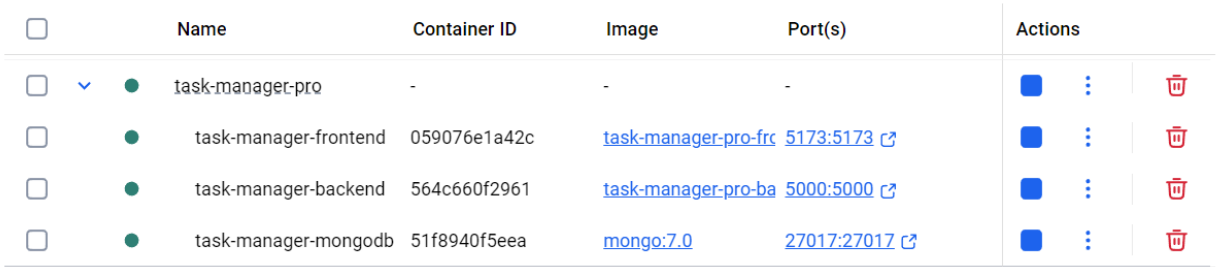
Main application interface showing task management features

API Health Check



Backend API health check endpoint response

Docker Containers



Docker containers running successfully

8. Docker Commands Reference

Basic Commands

```bash
# Build and start services
docker-compose up --build

# Stop services
docker-compose down

# View running containers
docker-compose ps

# View logs
docker-compose logs [service-name]

# Execute commands in container
docker-compose exec [service-name] [command]
```

Development Commands

```bash
# Rebuild specific service
docker-compose build [service-name]

# Scale services
docker-compose up --scale [service-name]=3

# Remove volumes
docker-compose down -v
```

9. Environment Configuration

Frontend Environment Variables

```env
VITE_API_URL=http://localhost:5000/api
```

Backend Environment Variables

```
env
PORT=5000
MONGODB_URI=mongodb://mongodb:27017/taskmanager
NODE_ENV=development
```

10. Testing the Application

Functional Testing Steps

1. **Access Frontend:** Navigate to http://localhost:5173
2. **Add Task:** Enter task title and click "Add Task"
3. **Mark Complete:** Click checkbox to toggle completion
4. **Filter Tasks:** Use filter buttons (All, Active, Completed)
5. **Delete Task:** Click delete button to remove task
6. **API Testing:** Access http://localhost:5000/api/health

Expected Results

- Frontend displays modern task management interface
- Tasks can be added, completed, and deleted
- Statistics update in real-time
- API returns JSON responses
- All containers run without errors

11. Network Configuration

Docker Network

- **Network Name:** task-manager-network
- **Driver:** bridge
- **Services Communication:** Internal DNS resolution

Port Mapping

- Frontend: Host 5173 → Container 5173
- Backend: Host 5000 → Container 5000
- MongoDB: Host 27017 → Container 27017

12. Volume Management

Persistent Data

- **MongoDB Data:** Persistent volume for database
- **Development Volumes:** Hot reload for code changes

13. Security Considerations

Backend Security

- Non-root user execution
- Input validation and sanitization
- CORS configuration
- Error handling middleware

Container Security

- Alpine Linux base images (smaller attack surface)
- Health checks for service monitoring
- Resource limitations through Docker Compose

14. Monitoring and Health Checks

Health Check Implementation

- Backend health check endpoint: `/api/health`
- MongoDB health check using mongosh
- Docker health check configuration
- Service dependency management

15. Troubleshooting Guide

Common Issues

1. **Port conflicts:** Change port mappings in docker-compose.yml
2. **MongoDB connection:** Ensure MongoDB service is healthy
3. **CORS errors:** Verify backend CORS configuration
4. **Build failures:** Check Dockerfile syntax and dependencies

Debug Commands

```bash
# Check container logs
docker-compose logs [service-name]

# Interactive shell
```

```
docker-compose exec [service-name] /bin/sh


# Inspect networks
docker network ls
docker network inspect task-manager-pro_task-manager-network
```

16. Conclusion

Task Manager Pro successfully demonstrates:

- **Containerization:** All services running in Docker containers
- **Service Orchestration:** Docker Compose managing multi-container application
- **Modern Architecture:** Separation of concerns with frontend, backend, and database
- **Development Workflow:** Hot reload and development-friendly configuration
- **Production Ready:** Health checks, security, and monitoring

The application showcases practical implementation of distributed systems concepts using Docker, providing a scalable and maintainable solution for task management.