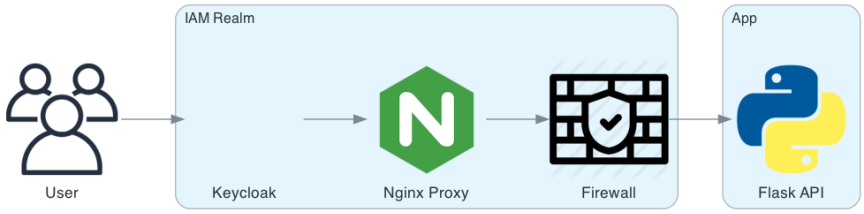
Identity and Access Management (IAM) System Report

Architecture Diagram

Below is a high-level architecture diagram of the IAM setup used in this project:

In [7]:
```
from diagrams import Cluster, Diagram
from diagrams.onprem.client import Users
from diagrams.onprem.network import Nginx
from diagrams.custom import Custom
from diagrams.programming.language import Python
from diagrams.generic.network import Firewall
from IPython.display import Image, display

# Define output path
output_path = "iam_architecture"

# Generate the diagram
with Diagram("Secure IAM Architecture with Keycloak and Flask", show=F
    user = Users("User")

    with Cluster("IAM Realm"):
        keycloak = Custom("Keycloak", "./resources/onprem/identity/key
        nginx = Nginx("Nginx Proxy")
        firewall = Firewall("Firewall")

    with Cluster("App"):
        flask = Python("Flask API")

    user >> keycloak
    keycloak >> nginx >> firewall >> flask

# Display the image below the code cell
display(Image(filename=f"{output_path}.png"))
```



Secure IAM Architecture with Keycloak and Flask

OAuth 2.0 and OIDC Flow

This project uses the **Resource Owner Password Credentials** (ROPC) flow of OAuth 2.0 with OpenID Connect (OIDC) via Keycloak as the Identity Provider (IdP).

Here's a simplified step-by-step overview:

1. **User Authentication**: The client sends a `POST` request to Keycloak's token endpoint with the username and password.
2. **Token Retrieval**: If the credentials are valid, Keycloak responds with an access token (and optionally an ID token).
3. **Token Usage**: The client uses this access token to call the protected Flask endpoint.
4. **Token Verification**: The Flask application verifies the token using the public JWKS endpoint provided by Keycloak.

This allows seamless, stateless authentication across microservices without maintaining sessions.

Threat Modeling (STRIDE)

In [4]:
```
!python3 -m ensurepip --upgrade
```

```
error: externally-managed-environment

× This environment is externally managed
╰─> To install Python packages system-wide, try brew install
    xyz, where xyz is the package you are trying to
```

```
    install.

    If you wish to install a Python library that isn't in Homebrew,
    use a virtual environment:

    python3 -m venv path/to/venv
    source path/to/venv/bin/activate
    python3 -m pip install xyz

    If you wish to install a Python application that isn't in Homebrew,
    it may be easiest to use 'pipx install xyz', which will manage a
    virtual environment for you. You can install pipx with

    brew install pipx

    You may restore the old behavior of pip by passing
    the '--break-system-packages' flag to pip, or by adding
    'break-system-packages = true' to your pip.conf file. The latter
    will permanently disable this error.

    If you disable this error, we STRONGLY recommend that you additiona
lly
    pass the '--user' flag to pip, or set 'user = true' in your pip.con
f
    file. Failure to do this can result in a broken Homebrew installati
on.

    Read more about this behavior here: <https://peps.python.org/pep-06
68/>

note: If you believe this is a mistake, please contact your Python inst
allation or OS distribution provider. You can override this, at the ris
k of breaking your Python installation or OS, by passing --break-system
-packages.
hint: See PEP 668 for the detailed specification.
Traceback (most recent call last):
  File "<frozen runpy>", line 198, in _run_module_as_main
  File "<frozen runpy>", line 88, in _run_code
  File "/opt/homebrew/Cellar/python@3.13/3.13.3/Frameworks/Python.frame
work/Versions/3.13/lib/python3.13/ensurepip/__main__.py", line 5, in <m
odule>
    sys.exit(ensurepip._main())
             ~~~~~~~~~~~~~~~~^^
  File "/opt/homebrew/Cellar/python@3.13/3.13.3/Frameworks/Python.frame
work/Versions/3.13/lib/python3.13/ensurepip/__init__.py", line 257, in
_main
    return _bootstrap(
        root=args.root,
    ...<4 lines>...
        default_pip=args.default_pip,
    )
  File "/opt/homebrew/Cellar/python@3.13/3.13.3/Frameworks/Python.frame
```

```
work/Versions/3.13/lib/python3.13/ensurepip/__init__.py", line 172, in
_bootstrap
    return _run_pip([*args, "pip"], [os.fsdecode(tmp_wheel_path)])
  File "/opt/homebrew/Cellar/python@3.13/3.13.3/Frameworks/Python.frame
work/Versions/3.13/lib/python3.13/ensurepip/__init__.py", line 87, in _
run_pip
    return subprocess.run(cmd, check=True).returncode
           ~~~~~~~~~~~~~~^^^^^^^^^^^^^^^^^^
  File "/opt/homebrew/Cellar/python@3.13/3.13.3/Frameworks/Python.frame
work/Versions/3.13/lib/python3.13/subprocess.py", line 577, in run
    raise CalledProcessError(retcode, process.args,
                             output=stdout, stderr=stderr)
subprocess.CalledProcessError: Command '['/opt/homebrew/opt/python@3.1
3/bin/python3.13', '-W', 'ignore::DeprecationWarning', '-c', '\nimport
runpy\nimport sys\nsys.path = [\'/var/folders/yg/vhs1hyrj3r38hcyc6ghj4v
2r0000gq/T/tmpl4f97by2/pip-25.0.1-py3-none-any.whl\'] + sys.path\nsys.a
rgv[1:] = [\'install\', \'--no-cache-dir\', \'--no-index\', \'--find-li
nks\', \'/var/folders/yg/vhs1hyrj3r38hcyc6ghj4v2r0000gq/T/tmpl4f97by2
\', \'--upgrade\', \'pip\']\nrunpy.run_module("pip", run_name="__main_
_", alter_sys=True)\n']' returned non-zero exit status 1.
```

Reflection on Okta Case Study

The breach of Okta's support systems in early 2022 highlighted the risks of third-party access and minimal privilege. This influenced our architecture design to:

- **Limit Token Lifetimes**: Short-lived tokens reduce risk from token theft.
- **Use Scoped Access Tokens**: Ensure tokens are limited in their permissions.
- **Audit Third-Party Integrations**: Validate and log all third-party activities.
- **Zero Trust Principles**: Assume no actor is trusted by default, even inside the network.

These considerations strengthen the overall security posture of our IAM setup.